MAY 1 9 1924

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION

ENGINEERING:

An Illustrated Weekly Journal.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXVII.—No. 3044.] *LONDON: FRIDAY, MAY 2, 1924.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 3d.

Aveling & Porter, Ltd., ROCHESTER.

Steam & Crude Oil Rollers.
SPECIAL ROLLERS FOR BITUMINOUS ROADS. 1869

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On Admiralty and War Office Lists.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 8.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, Ltd., Friars House, 39-41, New Broad St., LONDON, E.C.2.
See half-page Advert. last week and next week. 2087

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1867

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited, BIRMINGHAM. 1241
See Advertisement last week, page 19.

Spencer-Hopwood & Kirke PATENT BOILERS 1994
See Page 73.
Sole Makers: SPENCER-BONECOURT, Ltd., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. Ltd., Engineers, Newcastle-on-Tyne. 1864

P. & W. MacLellan, Ltd., CLUTHA WORKS, GLASGOW.
Manufacturers of RAILWAY CARRIAGES AND WAGONS of every description.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 8547
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Brett's Patent Lifter Co. Limited. Hammers, Presses, Furnaces, COVENTRY. 610

Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd., Newton Heath Glass Works, Manchester. Od 9753

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Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 617
The Scottish Tube Co., Ltd., Head Office: 34, Robertson Street, Glasgow.
See Advertisement, page 91, April 25.

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 1553

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 12 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD., PORTSMOUTH, SHIP & LAUNCH BUILDERS, Od 3551 ENGINEERS & BOILER MAKERS.

The Glasgow Rolling Stock and Plant Works.
Hurst, Nelson & Co., Ltd., Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS.
PRESSED STEEL WORK OF ALL KINDS. Od3382
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OIL FUEL APPLIANCES, *Systems* PRESSURE, AIR, STEAM *For Boilers of all types.*
KERMODES LIMITED, 35, The Temple, Dale Street, Liverpool.
Naval Outfits a Speciality, also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
Telephone No.: Central 2832.
Telegrams: "Warmth." 4078

Locomotives Tank Engines designed and constructed by MANNING, WARDLE AND COMPANY, LIMITED. Boyne Engine Works, Leeds. Od 2487
See their Illus. Advertisement, page 103, last week.

Gearing of all Descriptions.
GEAR WHEELS up to 10 ft. diameter.
FLY ROPE and SPUR DRIVING WHEELS up to 26 ft. diameter.
BRICK and CLAYWORKING MACHINERY of all kinds.
ENGINES:—"Uniflow," "Corliss," or Drop Valve.
CLAYTON, GOODFELLOW & CO., Ltd., Blackburn. 1949

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BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEEL and AXLES of all kinds
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices: WISHAW, near GLASGOW.
London Office: Od 8353
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MACHINE CUT Gears.
Spurs, Bevels, Spiral, Worm and Worm Wheels.
HIGHFIELD GEAR CUTTING CO. (Dept. E.), Huddersfield. 1645

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising, London." —Great Eastern Road, Stratford, E.15. 1794

Rosser and Russell, Ltd., Mechanical Engineers, QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
'Phone: Hammersmith 31, 967. 2211

John Bellamy, Limited, MILLWALL, LONDON, E. 1216
General Constructional Engineers,
Boilers, Tanks, & Mooring Buoys
Stills, Petrol Tanks, Air Receivers, Steel Chimneys, Riveted Steam and Ventilating Pipes, Hoppers, Special Work, Repairs of all kinds.

IRON & STEEL
Tubes and Fittings AND Steel Plates.
Stewarts and Lloyds, Ltd. GLASGOW BIRMINGHAM LONDON.
See Advertisement, page 90. 1872

Peter Brotherhood Ltd., PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 59, April 25.

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. Ltd.,
London Office—12, Victoria Street, S.W.
Manufacturers of RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1943

Electric Generating Plant for SALE.
Direct Current.

Two	26 Kw.	105 Volts.	"Howden-B.H.H.
Two	53 ,,	,, ,,	"Brotherhood-Laurence Scott."
Two	100 ,,	440/500 ,,	Garrett Semi-Portable.
One	120 ,,	110 ,,	"Bellis-Siemens."
One	150 ,,	220 ,,	"Howden-Lang, Dynamo."
Two	200 ,,	,, ,,	"W. H. ALLEN."
Two	200 ,,	,, ,,	"Bellis-Siemens."
One	240 ,,	440/500 ,,	"Bellis-Phœnix Dynamo."
One	375 ,,	250 ,,	"Allen-Westinghouse."
One	400 ,,	240 ,,	"Howden-Siemens."
One	500 ,,	230 ,,	"Howden-B.T.H."
One	500 ,,	230 ,,	"Bellis-B.T.H."
One	500 ,,	500 ,,	Metropolitan Vickers Turbo.
One	600 ,,	500 ,,	"Bellis-Mather & Platt."
One	750 ,,	220 ,,	"Parsons-Crompton" Geared Turbo.
One	1250 ,,	250 ,,	"Bellis" Turbo.

Alternating Current, 3-Phase, 50 Periods.

One	400 Kw.	500/550 Volts.	"Howden-G.E.C."
One	750 ,,	,, ,,	"Metropolitan Vickers."
One	850 ,,	,, ,,	"Fraser & Chalmers."
Two	1000 ,,	,, ,,	"Metropolitan-Vickers."
One	1000 ,,	3300 ,,	"B.T.H."
Two	1000 ,,	,, ,,	"Metropolitan-Vickers."
One	2000 ,,	500/550 ,,	,,
One	3000 ,,	6600 ,,	"B.T.H."

All above are modern, and condensing plant is available in nearly all cases.
We can also offer several Suction Gas and Diesel Sets, Babcock Boilers up to 30,000 lbs. per hour, and a very large number of motors, generators, Motor-generators, rotary converters, etc.
Enquiries Invited.
THE PHŒNIX ELECTRICAL COMPANY, Ltd., 17, OSWALD STREET, GLASGOW. 822

James D. Roots.—Patents, BRITISH and FOREIGN. Moderate charges, Long and varied practical Engineering experience valuable to Inventors. Formerly many years contributor of Patents Abstracts for "The Engineer" & "The Times."—Thanet House, Temple Bar, London, W.C.2.

Telegrams: "Ejaculate," London.
Telephone: 7424 Central.
E. P. Alexander & Son.
CHARTERED PATENT AGENTS,
308, High Holborn, London, W.C. 1. 585
PATENTS. DESIGNS. TRADE MARKS.

EXAMINATION AND PHOTOGRAPHY OF METALS. See F. Davidson & Co's. Advt., page 17. 2114

Royles Limited, ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS EVAPORATORS, CONDENSERS, AIR HEATERS, } ROW'S PATENTS,
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 1553

Matthew Paul & Co., Ltd., Levenford Works, Dumbarton. 1483
See Full Page Advt., page 40, April 25.

Forgings.
Walter Somers, Limited, HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works, and Showrooms: BIRMINGHAM.
See advert., page 96, April 25. 5195

"Delta" Brand HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., Ltd., 2033
E. GREENWICH, LONDON, S.E. 10 (& at Birmingham)

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 2006

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd., The Glasgow Rolling Stock and Plant Works, MOTHERWELL. Od 3383

HEAT INSULATION.
CELITE PRODUCTS CORPORATION, Windsor House, Westminster, S.W.1. 1675
See our Illustrated Advertisement, April 11.

GEARS OF EVERY DESCRIPTION.
Spring Grove, AUTOGEARS (Leeds), Ltd., Hyde Park Road, Leeds. 1743

Patents.—Exhibition Visitors can obtain information respecting patents, etc., from B. T. KING, Regd. Patent Agent, 146a, Queen Victoria St., E.C.4. For free appointment Wembley Exhibition, 'Phone Central 682. Handbook free.
ON ADMIRALTY LIST.

John Kirkaldy, Ltd., London Office: 101, Leadenhall St., E.C.3.
Works: Burnt Mill, near Harlow, Essex.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers, &c., &c. 1586

Centrifugals.
Pott, Cassels & Williamson, MOTHERWELL, SCOTLAND. 1676
See half-page Advertisement, page 70, April 11.

The Manchester Steam Users' ASSOCIATION,

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

University of Sheffield.

COURSES IN MECHANICAL ENGINEERING.

Professor F. C. LEA, D.Sc., M.Inst.C.E., M.I.Mech.E., Professor of Mechanical Engineering.
Degree, Associateship, and Works Pupils' Courses.
Applications are also invited from those desiring to do Research Work in Engineering.
Full particulars may be obtained from PROFESSOR LEA, Department of Applied Science, St. George's Square, Sheffield.
W. M. GIBBONS, Registrar. D 621

Battersea Polytechnic,

London, S.W.11.
Short Summer Courses of eight lectures will be held in the following subjects, commencing May 12th:—
Strength of Materials,
Theory of Structures,
Theory of Machines,
Hydraulics,
Heat Engines,
Machine Drawing and Design.
The above are revision courses suitable for the Final B.Sc., Eng., the A.M.I.C.E., or the A.M.I.M.E. Examination.
Also a special Course of lectures with practical testing, on Petrol Engines.
For further particulars apply to the PRINCIPAL. D 623

Borough Polytechnic INSTITUTE.

ENGINEERING DEPARTMENT.
Head of Department:
G. E. DRAYCOTT, Wh.Ex., A.M.I.Mech.E.
SUMMER CLASSES, 1924.
SHORT COURSES of TEN LECTURES, each commencing 28th April, will be held in the following subjects:
Toothed Wheel Gearing and Drawing Office Practice. B. HARWOOD, Dip.M.E., A.M.I.C.E.
Principles of Refrigeration — Elementary and Advanced. G. H. LAURENSON, A.M.I.Mech.E.
Strength of Materials and Structures. F. G. SMITH, Wh.Ex., A.R.C.S.
Low Pressure Fans and Blowers. H. L. JOSELIN, A.C.G.I., A.M.I.C.E.
Elementary Steam Turbine Types. G. H. MORGAN, A.R.C.S., D.I.C. D 641
Advanced Workshop Methods and Processes. A. H. HALL, A.M.I.C.E., A.M.I.M.E.
Acetylene Welding. J. F. HUMPHREY, M.I.W.E.
For particulars apply, J. W. BISPHAM, Principal.

Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to S/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1993

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of Training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 2108

TENDERS.

LODGE HILL, NEAR CHATHAM.

Tenders are Invited for

the PURCHASE and REMOVAL of the undermentioned TIMBER FRAMED HUTS, now at Chattenden Farm, Lodge Hill, and of approximate floor measurements as follows:—

4 No.	66 ft. by 17 ft.
7 No.	61 ft. by 21 ft.
1 No.	50 ft. by 16 ft.

Tenders are to be delivered not later than Noon on 10th May, 1924, to SUPERINTENDING CIVIL ENGINEER, H.M. Dockyard, Chatham, from whom full particulars and Forms of Tender may be obtained. D 629

THE BENGAL AND NORTH WESTERN RAILWAY COMPANY, LIMITED.

THE ROHILKUND AND KUMAON RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive

Tenders for the Supply of:—

(a) MATERIALS for 835 O.G. wagons and 20 Timber Trucks,
(b) 1902 prs. WHEELS AND AXLES for carriages and wagons,
(c) 3500 AXLEBOXES for wagons,
(d) 3500 VOLUTE AND HELICAL SPRINGS for wagons,
(e) 3500 LAMINATED SPRINGS for wagons,

as per Specifications to be seen at the Company's Offices.
Tenders addressed to the undersigned, and marked "Tender for Wagons," or as the case may be, with name of firm tendering, to be lodged not later than Noon on Monday, the 26th day of May, 1924.
For specifications (a) and (b) a fee of £1 each, and (c), (d) and (e) 10/- each, will be charged, which cannot, under any circumstances, be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By order of the Board,
R. A. NEVILLE,
Managing Director,
Secretary.
237, Gresham House, Old Broad Street, London, E.C.2.
28th April, 1924. D 626

METROPOLITAN WATER BOARD.

SUPPLY OF POSITIVE TYPE WATER METERS.

The Metropolitan Water Board invite

Tenders for the Supply of

500 ¾ in., 150-¾ in., and 50-1 in. POSITIVE TYPE WATER METERS delivered to their works at Rosoman Street, Clerkenwell, E.C.1.
Forms of Tender may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery Avenue, E.C.1, by personal application (Room 155), or upon forwarding a stamped addressed brief envelope.
Tenders must be on the official forms, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery Avenue, E.C.1," endorsed "Tender for Water Meters," and delivered at the offices of the Board not later than Eleven a.m. on Monday, 12th May, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, New River Head, 173, Rosebery Avenue, E.C.1.
26th April, 1924. D 625

G. R.

GEORGE COHEN & ARMSTRONG, DISPOSAL CORPORATION.

Offer for Sale by

PUBLIC TENDER.
PLANT and MACHINERY, ROLLING MILLS, MACHINE TOOLS, RAILWAY MATERIAL and MISCELLANEOUS STORES,
at the
SOUTHAMPTON DEPOT.
The Material includes
ROLLING MILLS and SPARES.
Eight Set Rolling Mills in two sets of four rolls 16 in. by 18½ in., 17 in. by 18½ in., 15 in. by 18 in. driven by 400 h.p. slip ring motors, by Robertson and Co.
Six set Rolling Mills in two sets of three rolls 29 in. diameter by 25 in. and 18 in. by 21 in. by Robertson & Co.
Two set Rolling Mills by Robertson & Co., 12 in. by 12 in.
Spare Rolls 18 in. by 20 in.—17 in. by 18 in.—16 in. by 18 in.—15 in. by 18 in.—15 in. by 18 in.—12 in. by 12 in.—24 in. by 12 in.—34 in. by 30 in.—20 in. by 30 in.—20 in. by 24 in.
Three Main driven Gear Wheels for 12 in. Mill.
Brass bearings for 15 in. to 24 in. Mills.
Coupling boxes from 12 in to 24 in. Mills.
Guide bars, breaker blocks, wobblers for 12 in. to 24 in. Mills, etc., and numerous other Spares.
PLANT and MACHINERY.
Seven sets of McDuff Muffle Furnaces.
Nine sets of Annealing Furnaces.
Crucible furnaces by J. Wright, 250 lbs. capacity.
Crucible Lip Axis Tilting Furnaces 18 in. dia. by 2 ft. 6 in., bevel and worm gearing by J. Wright.
Cast Iron Turntables for same.
Heating Furnaces (Greenhouse) by Lancaster and Sons.
Five Centrifugal Pumps by Gwynne & Co., 2 in. inlet.
4 in. Belt driven Vertical Pumps by Evans, 3½ in. ram by 2 in. stroke.
Vertical Well Pumps by Evans.
Taylor & Challen Cutting and Cupping Presses, daylight 7 in. by 7½ in.
14 h.p. Semi-Portable Steam Engine, by Marshall Sons & Co., twin cylinder 9½ in. dia. by 12 in. stroke.
Horizontal Compound Steam Engine, cylinder 9 in. dia. by 14 in. stroke, with portable Steam Boiler by Davey Paxman.
Guillotine Shearing Machine, capacity 2 in. by ½ in.
Buckton Bar Shearing Machine, blades 14 in., max. capacity 3 in. deep by 18 in. wide.
18 in. double ended Shears by De Bergue.
3 in. double ended disc Punching Machine by De Brugue, capacity 6 in. dia. by 45 in. thick.
60 in. Centrifugal Fans by Keith Blackman.
CRANES and LIFTING APPLIANCES.
3-ton Electric Jib Crane by Stothert & Pitt, 35 ft. jib.
15-cwt. Morris Hand Block.
3 ton Overhead Runway.
MACHINE TOOLS and WOODWORKING MACHINERY.
9 in. centre S.S. & Sc. Lathe.
5½ in. centre Capstan, 14 in. Slotting Machine, Power Grindstone by Buck & Hickman.
30 in. Band Saw by Wilson & Sons.
24 in. and 28 in. Saw Benches by Pickles.
18 in. double spindle Moulding Machine by Robinson & Sons.
ELECTRIC MOTORS AND ELECTRICAL MATERIAL.
Twelve 440 volts 3-phase 50 periods A.C. Motors, from 5 to 60 h.p.
Four 110 volts D.C. ditto, from 1½ to 10 h.p.
One D.C. 250 ditto, 25 h.p.
Megger Testing Sets, 500 volts, 300 amps.
Electro Dynamometers by Weston Electrical Inst.
Four Pyrometers.
Electric Hot Cupboards, Hot Plates, Cookers and Radiators.
Carbon Brushes, Porcelain Connections, Fuses, Fuse Holders and Insulators.
Resistance Coils, Bushes, Tumblers, Switches, 250 volt Electric Lamps, etc.
RAILWAY MATERIAL AND MISCELLANEOUS STORES.
1400 ft. 55 lbs. Crane Rails.
Large quantity of Cast Iron Moulds, Plumbago Crucibles for 125 and 250 lbs. capacity.
Shafting Pulleys, Blocks and Chain Slings, Iron Platform and Rails, 4½ in. to 6 in. Shears, Tube Cutter and Expander, Steel Elevator, Trucks, Telephone Box, 2 in. Steel Wire Rope. Guillotine and Cutter Blades, Iron Ladders, Sheaves for 5 in. and 12 in. Cranes, six Pressure Gauges, Scales and Weights, Wire Cutters, Pick Helves and Heads, Shovels, Spanners, Saws (Metal), Screw Drivers, etc.
CLOSING DATE OF TENDER—MAY 15th NEXT, CATALOGUE OF SALE AND FULL INFORMATION FROM
GEORGE COHEN & ARMSTRONG DISPOSAL CORPORATION,
Abbey House, Victoria St., S.W.1.
'Phone: Victoria 8040. Telegrams: "Cohstrong Sowest," D 543

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 23rd May,

Tenders for the Supply of

WHEELS AND AXLES.
Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 10/- each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices: 91, Petty France, Westminster, S.W.1.
30th April, 1924. D 666

WOODHALL SPA, LINCS.

The Urban District Council invite

Tenders to Provide and Fix

a DIRECT COUPLED, HEAVY FUEL, 4-CYCLE OIL ENGINE and AIR COMPRESSOR of 180 cubic feet per minute free air displacement, against 20 lbs. per square inch pressure.
Copies of Specification will be supplied by Mr. E. SALMON, Surveyor, Council Offices, Woodhall Spa, on the payment of £1 in., which will be refunded on receipt of a *bona fide* Tender.
Tenders to reach me not later than 22nd May, 1924.
The Council do not bind themselves to accept the lowest or any Tender.
By Order,
J. E. CHATTERTON, Clerk.
4, Church Lane, Horncastle.
28th April, 1924. D 617

ABERDEEN CORPORATION WATER WORKS.

EXTENSIONS 1920.

Contract No. 19.—PIPELAYING.

The Town Council of Aberdeen are prepared to receive

Tenders from Competent

Persons willing to enter into a Contract for the TRANSPORTING, LAYING and JOINTING of about 5500 lineal yards of CAST IRON PIPES, from 30 in. to 13 in. in diameter, and Ancillary Works in and near the City of Aberdeen.
The Drawings may be inspected and Specification, Schedule of Quantities, and Form of Tender obtained on and after 2nd May, 1924, on application at the Water Engineer's Office, 41½, Union Street, Aberdeen. Early application is desirable, and no Specification will be given out after 12th May.
For each Specification a deposit of Five Pounds Sterling will be required, which sum will, after a Tender has been accepted, be returned to the Tenderer, provided that he shall have sent in a *bona fide* Tender, based on the Drawings, Specification, and Schedule of Quantities provided, with the Schedule of Quantities fully priced out in detail, and shall not have withdrawn the same.
The employment of labour shall be in accordance with the conditions of the Unemployment Grants Committee.
Tenders on the forms prescribed, and enclosed in securely sealed envelopes, endorsed "Tender for PIPELAYING," are to be addressed to the undersigned. No Tender delivered after Twelve Noon, on 19th May, 1924, will be considered.
The Town Council do not bind themselves to accept the lowest or any Tender.
GEORGE B. MITCHELL, M.Inst.C.E., F.C.S. Water Engineer's Office, 41½, Union Street, Aberdeen, 29th April, 1924. D 648

CITY OF SHEFFIELD.

Electric Supply Department.

NEW ELECTRICITY GENERATING STATION.

The Electric Supply Committee invite

Tenders as follows, for

Buildings, Works and Plant required in connection with the erection and equipment of a new Electricity Generating Station at Blackburn Meadows, Sheffield.

SPECIFICATION	B.M.64.	Buildings and Civil Engineering Works.
,,	B.M.65.	Constructional Steelwork.
,,	B.M.66.	Transformers.
,,	B.M.67.	Turbo-Alternators including Condensing Plant.
,,	B.M.68.	Water-tube Boilers, with Chimneys, Superheaters Stokers, Economisers and all accessories.
,,	B.M.69.	Pipework and Valves.
,,	B.M.70.	Wagon Tippers, Conveyors and Elevators.
,,	B.M.71.	E.H.T. three-phase switchgear.
,,	B.M.72.	Cooling Towers.
,,	B.M.73.	Overhead electrically and hand operated Travelling Cranes.
,,	B.M.74.	Battery Shunting Locomotive and accessories.

Contractors desiring to submit Tenders may see the Drawings and obtain the separate Specifications and Forms of Tender at these offices on and after Monday, 5th May, 1924, on making a deposit of £3 in respect of each specification. Sums paid for any number of each specification up to three will be refunded on receipt of a *bona fide* Tender.
Contractors may Tender for all or any of the above sections.
Any person or Firm sending in a Tender will be required to add a schedule to such Tender stating the names of the various classes of labour which he or they intend to employ, together with the place where such labour will be employed, and the rates of wages, hours of labour, and conditions of employment to be paid and observed in respect of each class of labour, all of which as shown in such schedule shall comply with the City Council's form of clauses respecting wages, hours and conditions of labour, and prohibition against assigning and sub-letting.
Tenders, which must be made out on the official Tender Form to be delivered at these Offices (enclosed in the official envelope provided) not later than Noon on Tuesday morning, 3rd June, 1924.
The Committee do not bind themselves to accept the lowest or any Tender.
S. R. FEDDEN, M.Inst.C.E., General Manager & Engineer.
Commercial Street, SHEFFIELD. D 615

The Director-General,

India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E.1,
REQUIRES:—
1. RAILS and FISHPLATES.
2. SLEEPERS, Steel.
3. DRAGLINE EXCAVATOR, mounted on caterpillar tractors, height of boom 80 ft., fitted for coal and oil burning.
Tenders due on the 15th May, 1924, for Nos. 1 and 2, and on the 19th May, 1924, for No. 3.
Tender forms obtainable from above. D 635

CORPORATION OF DURBAN, NATAL.

The Corporation of Durban, Natal, is prepared to receive

Tenders (from Manufacturers

only) for the SUPPLY and DELIVERY "Free on Board" British Port (or C.I.F. or Stores, Durban, if convenient) of Five Miles of SINGLE TRAM TRACK complete with Bonds, to be approved by the Representative Engineers, Messrs. W. H. RADFORD & SON, Albion Chambers, King Street, Nottingham.
On depositing £2 2s., returned on receipt of Tender, specifications by E. F. DAVIS, Borough Engineer, Durban, can be obtained from and sealed and endorsed Tenders must be delivered to the undersigned on or before May 17th, 1924.
The lowest or any Tender will not be necessarily accepted.
By Order,
WEBSTER, STEEL & CO., 36, Leadenhall Street, London, E.C.3.
Agents to the Corporation. D 604

APPOINTMENTS OPEN.

THE UNIVERSITY OF MANCHESTER.

Applications are Invited for

the POST of ASSISTANT LECTURER in ENGINEERING. Stipend £300 per annum.
Candidates should have some Civil Engineering experience and be able to give assistance in the Surveying Field courses.
Applications should be sent to the Internal Registrar not later than 21st June.—Further particulars may be obtained on application to the INTERNAL REGISTRAR. D 595

Traveller Wanted by Firm

of Old-established Machine Tool Makers making heavy tools as used by Shipbuilders, etc. Applicants must be experienced in this class of work, and to the right man a Directorship may be acquired. State age, Experience and Salary, in confidence.—Address, D 523, Offices of ENGINEERING.

The Sudan Government Railways

REQUIRE the SERVICES of a DISTRICT LOCOMOTIVE SUPERINTENDENT. Age 26 to 32, preferably single. Candidates should have been trained on a British railway or in a locomotive builder's works, and should have good knowledge of the working of a locomotive department. Commencing salary £E.480 to £E.540, according to age and qualifications. Permanent and progressive post if satisfactory. A.M.I.C.E. degree or equivalent desirable. Strict medical examination. Free first-class passage. Liberal leave and assisted passages.—Apply, by letter, to CONSULTING MECHANICAL ENGINEER, Sudan Government Railway, 5, Northumberland Avenue, W.C.1. D 568

EAST INDIAN RAILWAY.

PRINCIPAL FOR JAMALPUR TECHNICAL SCHOOL.

Applications are Invited (by

letter only) for the NEW POST of PRINCIPAL of the JAMALPUR (India) TECHNICAL SCHOOL.
2. Jamalpur is the headquarters of the Locomotive and Electrical Departments of the East Indian Railway. In the Railway workshops at Jamalpur, training is given in Mechanical, Electrical and Signal and interlocking work to European and Indian Apprentices, who also attend classes at the existing Technical School.
3. A new Technical School is to be constructed and the services of a Principal are required as early as possible.
4. The Principal, in addition to taking charge of and teaching in the present School, will be required to give his advice in regard to the construction and equipment of the new School, and to organise the new courses of study.
5. The object of the School is to give to the Apprentices that fundamental knowledge of scientific principles which is the complement of their practical work, and with which it is essential they should be thoroughly conversant, in order that they may clearly comprehend the plant they have to deal with, the machines and tools they use, and the workshop processes they are engaged upon.
6. The qualifications of the Principal must be as follows:—
(1) He must have served an apprenticeship in a British Mechanical Engineering Workshop of first-class repute.
(2) He must hold an Engineering Degree of a British University,
(3) He must have a knowledge of Electrical Engineering in addition to Mechanical Engineering.
(4) He must have had teaching experience of the kind (indicated above) required for the new Technical School.
(5) His age must not be less than 30 years.
7. The post of Principal will carry a commencing salary of Rs. 1000/- to Rs. 1200/- according to qualifications, rising by annual increments of Rs. 100/- to a maximum salary of Rs. 1500/-.
8. Engagement will, in the first instance, be for four years.
9. A free first-class passage will be granted for the voyage out to India.
10. The selected candidate will be required to pass a medical examination by the Company's Consulting Physician before appointment.
11. Letters of application, with copies (NOT ORIGINALS) of testimonials, should be addressed to the undersigned not later than Friday, the 23rd May, 1924.
By Order,
G. R. LILLIE, Secretary.
73-76, King William Street, London, E.C.4.
29th April, 1924. D 651

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THE TRANSVERTER.

IT is many years since any new type of electrical machinery has aroused such interest as the "Transverter," which appears likely to bring about fundamental changes with regard to the long-distance transmission of electrical power. The primary function of this very remarkable piece of apparatus is to convert ordinary alternating current into continuous current at an exceedingly high voltage for purposes of transmission, and to reproduce alternating current by a converse operation at the point where the power is to be distributed or used. The construction of the machine has been occupying the attention of Messrs. Dick, Kerr and Co., Limited, and latterly of their successors, the English Electric Company, Limited, for several years. In 1918 it became possible to construct the first experimental plant, and patents in the name of Mr. W. E. Highfield and Mr. J. E. Calverley who had carried out the researches at the Preston works of Dick, Kerr and Company were taken out. With commendable reticence, however, no public claims were made about the invention which would excite anticipations which might not be fulfilled. Hence, up to the present nothing has been made public concerning it. Now, however, that the many new and difficult problems involved in the design appear to have been satisfactorily solved, it has been decided to exhibit a Transverter at Wembley on the stand of the English Electric Company, Limited, where it constitutes undoubtedly the most interesting of all the electrical power apparatus at the Exhibition.

Before dealing with the machine itself, it will not be out of place to indicate the reasons which promise it a large field of usefulness. Long experience has shown that for the first generation of electric power, three-phase alternating current at a reasonable pressure, say, from 6,600 volts to 10,000 volts, is the most convenient and economical. Pressures of this order are, moreover, very suitable for ordinary distribution systems, the current being reduced to any desired voltage by means of static transformers at the points where it is to be utilised for purposes of power or lighting. When electricity has to be transmitted over long distances the present practice is to operate the transmission lines at much higher pressure, 33,000 or even 66,000 volts being used in the case of underground transmissions, and 150,000 volts or more when overhead mains are employed. Such pressures are necessitated by the desire to save copper in the conductors, and they can be obtained with the utmost ease by means of transformers. They impose, however, a severe strain on the insulation of the transmission system, which is increased by surges due to switching or other disturbances. The electrical characteristics of the circuits, moreover, come into prominence when the lines are long and questions of inductance and capacity become of serious importance. With continuous current almost all the difficulties disappear, and had there been any practical way of getting continuous current at the high voltages required, there is little doubt that long-distance transmission would have been generally or always carried out on this system. For a given effective voltage the strain on the insulation would be very considerably less with continuous than with alternating current, less copper could be used for a given transmission loss, and all troubles due to surges of current would be eliminated. The advantages of alternating current in respect of generation and distribution are so very great that there is at present no question of it being superseded by any other system, but by combining existing methods of generation and distribution with extra high tension continuous current transmission, an almost ideal state of affairs would be brought about.

It is, as we have said, the function of the "Transverter," which is the invention of Mr. W. E. Highfield and Mr. J. E. Calverley, to make this combination possible. The name "Transverter" is a combination of the words "transformer" and "rotary converter," and indicates, in a general way, the part it plays. The Transverter, however, is not a rotating machine at all, except in so far as certain brush gear is concerned, and its construction is such that the continuous current may be produced at any desired voltage, 100,000 volts being adopted in the first machine to be built. Moreover, whereas the object of the usual transformer-converter combination is to change high-tension three-phase alternating current to continuous current at a comparatively low voltage for immediate use, the transverter is essentially a machine for changing alternating current to continuous current at very high voltage for transmission purposes. Being perfectly reversible, a similar unit will convert back the continuous current into alternating current at any desired voltage for distribution or use.

The principle of the Transverter will be best understood by considering in the first place an ordinary dynamo of the old "Gramme ring" type. Such a machine is shown diagrammatically in Fig. 1. Its armature consists of an iron ring completely wound with a continuous coil of wire, the ends of which are connected together to form a closed winding. At equal intervals along the coil tappings are taken off and connected to their respective commutator bars. If such an armature rotates in a two-pole field, current will be generated in the winding, and can be led away to an external circuit by means of a pair of fixed brushes in contact with the commutator. It is evident that the same result would be obtained if the armature were held stationary, and the field magnets and brushes rotated round it, a relative rotation of the two components being all that is necessary to produce current. Considering then the armature as fixed, it is clearly immaterial how the moving magnetic field is produced, whether by the actual rotation of masses of iron or by some other means. A rotating magnetic flux caused by a three-phase current flowing through a stationary winding, is one of the commonest features of electrical machinery, being the basis of the design of every three-phase electric motor in existence. Such a flux would obviously serve to generate current in the coils of the stationary Gramme-ring armature we are considering, and nothing further would be necessary to enable it to act as a continuous current dynamo, except that means must be provided to rotate the brushes at a speed equal to that of the rotating flux. A small synchronous motor worked by the current causing the rotating flux would easily furnish the small amount of power required for this purpose.

Such a design as we have indicated would fulfil all the electrical requirements of a continuous-current dynamo, or rather of a machine to convert three-phase electrical energy into continuous current. Since the whole of the windings, whether on the field or the armature, would be stationary, they would be free from all centrifugal stresses and could be easily insulated. They could, in fact, be completely immersed in oil, which not only affords facilities for cooling, but also constitutes the most effective insulation yet devised. Thus, very high voltages could be used with safety, and as the employment of several independent armature windings so disposed that they all went through the same induction changes at the same instant, would provide the equivalent of an equal number of ordinary dynamos connected in series, much higher voltages could be generated than with an ordinary machine.

The idea of the design from which the present Transverter has been developed arose as the result of a request to produce a machine to generate high-tension continuous current. The power required was 20 kw. at 12,000 volts. Limitations of practical designing precluded so high a voltage being obtained from any single dynamo of the ordinary type, and the only known alternative was to use at least four such machines connected in series. The arrangement would have been so clumsy that something better was obviously needed, and it occurred to the inventors that a machine might be developed on the lines of the stationary Gramme-ring armature as discussed above. In view of the voltage required, they decided to wind the armature coils on porcelain spools, which could be slipped over the iron core of the "Gramme-ring." Each spool contained four divisions, separated by flanges, the divisions being wound independently of each other. Corresponding coils were connected together in series, so that the armature contained four separate windings. Each winding had its own commutator to which were connected tappings from the individual coils forming the winding in question. The commutator brushes were of course connected in series, so that four times the voltage generated in each winding was available across the whole machine. The latter was quite compact, and as the current to be dealt with was small, the commutators could be made with copper studs arranged in a circle, so that air insulation was obtained between the bars.

A machine of this kind was not, of course, of an economical design, as judged by ordinary standards. In the first place, the use of a Gramme-ring armature involves half the windings being always inactive, because they are shielded by the core from the rotating flux. Furthermore, the use of spools for the windings results necessarily in a large air-gap, and this involves a large field current to get the required flux across. Nevertheless, the principle of the machine was sound, and the design met the necessary requirements of an extra-high-tension machine for the special purpose for which it was required. It was only when larger powers came to be considered that the inherent defects of the design became so important that they rendered the type impracticable. Calculations showed that a machine of 1,000 kilowatts capacity would require an armature from 20 ft. to 30 ft. in diameter, if constructed along the lines described. This, of course, would be out of the question, and some means had to be found of embodying the underlying principle of the Gramme-ring in a form more economical both of energy and of material.

The ingenuity of the inventors was equal to the occasion, and they devised a solution which was really admirable both from the theoretical and practical points of view. If one considers any section of the core of the Gramme-ring armature above referred to, which is enclosed in a single coil, it will be seen that this part of the core is subject to a cyclic fluctuation of magnetism, the flux rising and falling in unison with the alternations of the exciting current. This cyclic variation of flux, of course, generates a corresponding alternating voltage in the coil of the armature. It is evident that the conditions are, electrically, in all ways, similar to those obtaining in an ordinary transformer, while the construction of the latter is much more efficient and mechanically advantageous than that of the Gramme-ring with its exciting coils. Hence, it appeared possible to substitute a transformer construction for the original design, and thus to obtain a great reduction of the dimensions otherwise necessary with a simultaneous increase in efficiency. All high-tension windings being still stationary, their immersion in oil was equally possible, and, indeed, greatly facilitated by the reduction in bulk and the improvement in shape which the transformer design permitted.

The design of a machine along the lines we have indicated appeared so promising that the English Electric Company decided to have one built, which moreover should be of sufficient size to discover any practical difficulties which might be encountered in the design. This first experimental "Transverter," which is still at Preston, has a nominal rating of 250 kw., and when the primary winding is supplied with three-phase current at 2,000 volts and 50 cycles, the machine will deliver 2·5 amperes of direct current at 100,000 volts. It consists of a number of static transformers connected to the three-phase supply in such a manner that each goes through its normal magnetic cycle. All the transformers, however, have different phase displacements and in only one is the flux passing through its maximum or minimum value at any instant. The secondary coils, therefore, have voltages induced in them which are displaced in time in the same manner as the magnetic fluxes in the different cores. The secondary coils, therefore, correspond to the armature coils on a direct-current generator of the Gramme-ring type, which all come in turn under the influence of the poles, and also follow on in definite order through their positions of zero voltage.

The experimental machine comprises six three-phase transformers, or the equivalent of eighteen single-phase transformers. Each transformer leg carries two secondary coils, one of which is connected in reverse direction to the other. The result is that the secondary current consists of 36 distinct phases, evenly spaced in time, with a phase displacement

between any one and the next of ten electrical degrees. Reference to Fig. 2 will make clear the relationship between the secondary phases. The 36 radial lines are rotating vectors, representing the voltages induced in the secondary windings. The projection of each on the vertical XY gives the instantaneous value of the induced voltage in that particular winding at the moment considered. For example, the length OZ represents the voltage in the phase 13A. The number at the end of each vector is the phase number of the corresponding secondary coil, and it will be noticed that the numbers with "A" affixed are opposite similar numbers without the affix. Each pair of coils with the same number are on the same core, but are connected in reverse direction, as explained above, in order to get the required phase displacement of 180 electrical degrees. As the sequence of the numbers in Fig. 2 indicates, the phases are not grouped in numerical order in the transformers, but a three-phase grouping is employed on the primary side and a six-phase grouping on the secondary side. The six-phase secondary of the first of the six three-phase transformers which constitute the machine comprises phases 1, 7, 13, 1A, 7A and 13A; the next transformer carries the secondary phases 2, 8, 14, 2A, 8A and 14A, and so on. The transformers themselves are arranged in two tiers of three transformers, each for immersion in the oil tank. An idea of the dimensions of the apparatus will be given by Fig. 3, which illustrates the core of one of the three-phase transformers in question.

The primary, or low-tension, windings of each phase are all connected in series, the three phases being star connected. The three cores of transformer No. 1 carry one primary winding each. All other transformer cores are excited by two separate primary windings connected to two different phases. The three-phase system being balanced, the current will have the same value in each phase. The magnetising force of each primary winding will, therefore, be proportioned to the number of turns, and in those cores carrying two primary windings the total magnetising forces will be the resultant of the magnetising forces produced by the separate phases. It is obvious that by combining magnetising forces of different values and phases any required phase displacement of the magnetic cycle of any particular core may be obtained. The ease with which the phase displacements can be obtained will be understood from Figs. 5, 6 and 7. The first of these diagrams represents the magneto-motive force in any one of the three cores of transformer No. 1, which, it will be remembered, are respectively excited by the three phases of the main alternating current supply. In the corresponding core of transformer No. 2 an equal magneto-motive force is, of course, required, but it has to be displaced by 10 deg. with reference to that in transformer No. 1. This is obtained by winding the second transformer limbs with two coils, one composed of 26 turns of one of the primary phases, and the other composed of 6 turns of another of the other phases connected in a reverse direction. The total magneto-motive force of the two combined is, as will be seen from Fig. 6, equal in magnitude to that of the corresponding single coil on the first transformer, but displaced by 10 deg. The limbs of the third transformer are wound with 22 turns of one primary phase and 12 reversed turns of another, thus giving a 20-deg. phase displacement of the magneto-motive force. By similar methods the whole of the required 36 phases can be obtained.

The coils forming the secondary, or high-tension, windings are evenly distributed on all the 18 cores, so that there are the same number of secondary turns on each transformer. The electro-motive forces induced on the secondary coils are all equal in value, but are displaced in phase from each other in exactly the same manner as the magneto-motive forces. The winding is a two-circuit one, and is electrically equivalent to a two-pole Gramme-ring armature, although the resemblance is not recognisable in the actual construction. The two circuits correspond to diametrically opposite phases in Fig. 2, and they are connected to the commutator in opposite directions to form a singly re-entrant winding. This will be understood by reference to Fig. 1, which shows a number of armature coils in the form of a Gramme-ring, connected to a commutator and rotating on a magnetic field. Coil No. 16 is seen to be just leaving the positive brush, and coil No. 16A is in the same position with respect to the negative brush. The coils numbered 1 and 1A are about midway between the brushes and are generating their maximum voltage. Coils No. 16 and No. 1 form part of one circuit through the armature, and coils No. 16A and 1A form part of the other circuit. The voltages induced in coils No. 1 and No. 1A are equal, but are opposite in sign, and by following out the action of all the coils it becomes evident that coils diametrically opposite are generating voltages which are equal and of opposite polarity, and are always in different circuits.

In the Transverter the secondary coils, which are opposite in polarity and voltage, are carried on the transformer cores, and are connected to the commutator in opposite directions. Thus coils 1 and 1A have their voltage induced by one primary winding; coils 2 and 2A by another primary winding, with the requisite phase displacement. The voltage distribution round the commutator at all loads is of a sinusoidal form, and as there can be no field distortion in the transverter a higher voltage per bar is permissible on the commutator without danger of flashing over. Referring again to Fig. 2, which shows the phase displacements of the secondary windings, at the instant depicted coils No. 16 and No. 16A are at zero potential and are therefore in a position suitable for commutation. The first-mentioned coil is changing from positive to negative, and the second from negative to positive, and their positions correspond to the positions of the brushes on the commutator. The coils between the brushes are in series and their effects are cumulative, so that the resultant potential of the whole of the coils is obtained at those coils which are connected to the brushes at any instant.

The coils are all going through their magnetic cycles with the frequency of the supply, and in their proper order, so that if the coils are considered as fixed, as they are in the Transverter, it is evident that each brush must travel completely round all the coils in one cycle of the field. With a frequency of the current in the primary windings of 50 cycles per second, the brushes should therefore rotate at a speed of 3,000 revolutions per minute. The connections to the commutator can, however, be so arranged that all the coils can be passed by the brushes in one-half or one-third of a revolution, when a brush speed of 1,500 or 1,000 revolutions per minute will be adequate for the respective cases. In the experimental Transverter the commutator has been connected in a manner similar to that of a four-pole direct-current armature, so that the brushes have to rotate at 1,500 revolutions per minute, which is the four-pole synchronous speed.

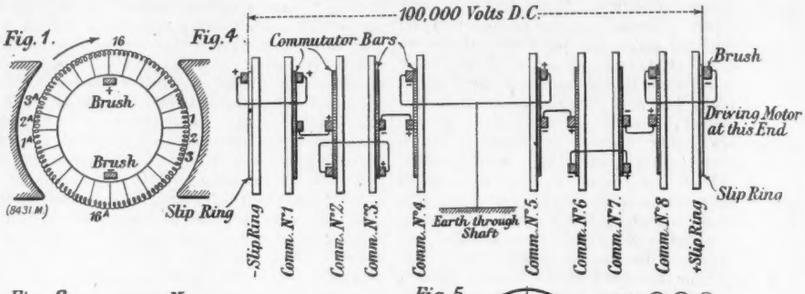


Fig. 1.

Fig. 2.

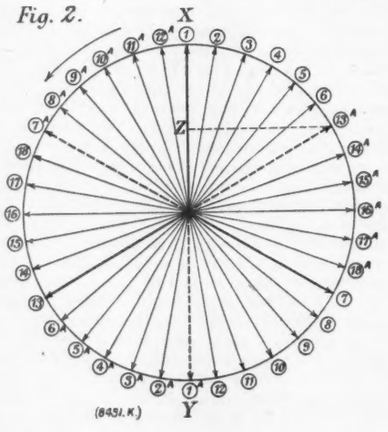


Fig. 3.

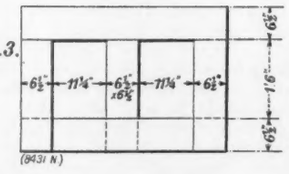


Fig. 4.

Fig. 5

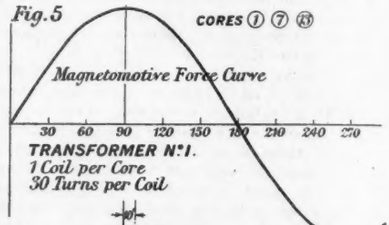
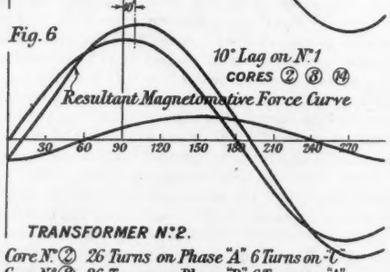
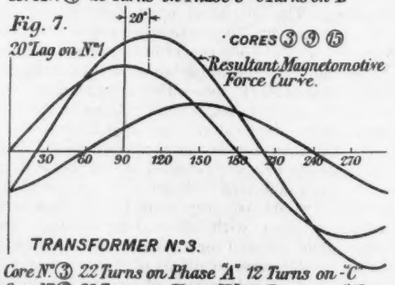


Fig. 6



Core N°② 26 Turns on Phase "A" 6 Turns on "C"
Core N°⑧ 26 Turns on Phase "B" 6 Turns on "A"
Core N°⑭ 26 Turns on Phase "C" 6 Turns on "B"

Fig. 7.



Core N°③ 22 Turns on Phase "A" 12 Turns on "C"
Core N°⑨ 22 Turns on Phase "B" 12 Turns on "A"
Core N°⑮ 22 Turns on Phase "C" 12 Turns on "B"

The secondary windings comprise 2,296 sections of 30 turns each to give 100,000 volts at the terminals of the machine, and there are consequently 2,296 commutator bars. In order to limit the voltage per commutator, and also to reduce the diameter which would otherwise be necessary, the commutator bars are arranged to form eight commutators, which are connected in series by the brushes. This arrangement of commutators has several advantages, besides those already mentioned, such as the dividing up of the whole voltage and the greatly increased sparking and creeping distances which the design permits. The secondary windings are also divided into eight entirely separate and distinct windings, each connected to its own commutator, each winding being thoroughly insulated from the next and from earth. The windings are

100,000-VOLT TRANSVERTER AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, PRESTON.

Fig. 8.

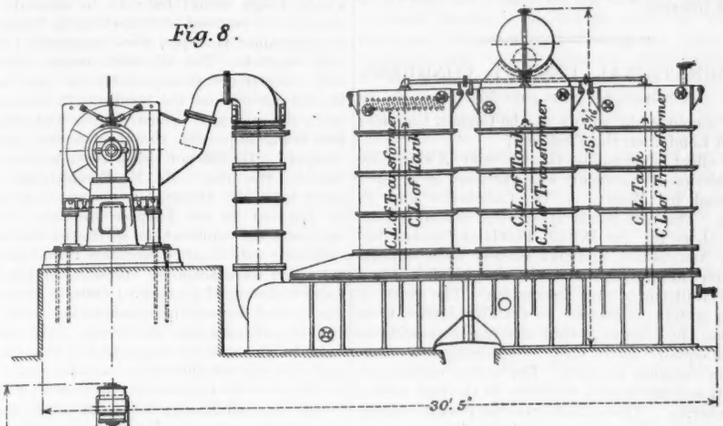
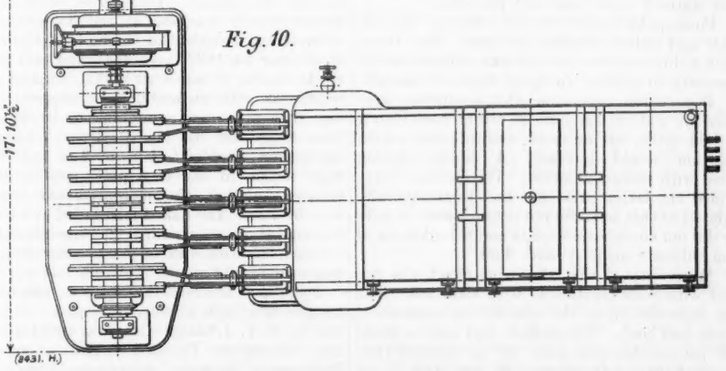


Fig. 10.



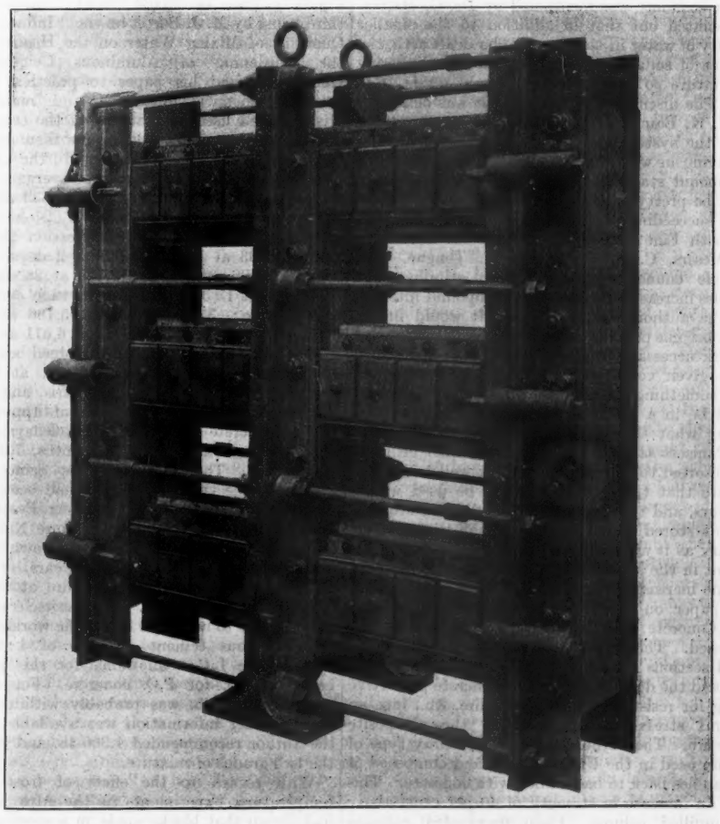
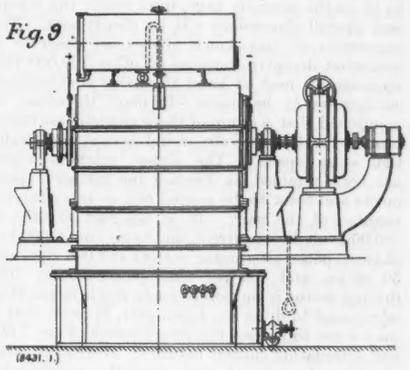


FIG. 11. SIX-PHASE TRANSFORMER CORE.

Fig. 9.



only connected to each other through the commutator brushes. A point of mid-potential which is half-way, electrically, between the terminals is connected through the commutator shaft to earth, so that the greatest difference of potential between any part of the windings and earth cannot exceed 50,000 volts. The arrangement of the eight commutators, with their brush connections and the mid-point earthing connection, is shown diagrammatically in Fig. 4.

The commutators are of the disc type, the bars taking the form of copper studs. They are arranged in circles of 24 in. diameter, with an air space of slightly over one-sixteenth of an inch between successive bars. The maximum voltage per bar is 264 volts. Carbon brushes are used. The connections from the secondary windings of the transformers to the commutators are carried in thirty-two 72-wire cables, specially made by the British Insulated and Helsby Cables, Limited, for the purpose. Each cable, which is 2·565 in. diameter over the sheathing, contains 18 groups of four wires each, disposed around a central core of rope. The wires and the groups are paper insulated for oil immersion, and the cables are guaranteed to stand 2,000 volts for 15 minutes between the wires of each group, and 25,000 volts for the same period between the various groups. The brush-gear is driven by a 15 h.p. synchronous motor, taking three-phase 50-cycle current at 2,000 volts from the same supply as that used to operate the transverter. The motor is excited by direct current at 110 volts and is fitted with dampers to prevent hunting and to enable it to start as an induction motor.

From the brief general description of the machine which we have given above it will be evident that the Transverter is not only of unusual interest from the electrical point of view, but appears likely to open the field to the commercial use of extra-high tension continuous current on a large scale. Its complete reversibility of operation will enable transmission lines to be worked by continuous current, with the possibility of great savings in capital cost and a reduction in operating troubles, while retaining all the advantages of the present method of generating and distributing electricity by means of alternating current.

We have dealt with the experimental Transverter at considerable length, partly because of its historical interest as the first machine of its type in the world, and partly because the explanation we have given of its principles of operation applies equally well to the larger machines that have since been constructed. The experimental machine so well fulfilled the anticipations of its designers that the English Electric Company at once put in hand a pair of much larger Transverters, embodying exactly the same principles and hardly differing in construction from the earlier machine except in such respects as were indicated by the greater size of the new sets. It is one of these latter machines which is now attracting such attention at Wembley. It is designed for an output of no less than 2,000 kw., and

delivers a continuous current of 20 amperes at 100,000 volts, when supplied with three-phase fifty cycle alternating current at 6,600 volts.

A general arrangement of the complete Transverter, as exhibited at Wembley is shown on Figs. 8 to 10 on the previous page, from which the layout and overall dimensions will be clearly seen. The impression of size which strikes an observer is somewhat deceptive because no other 100,000 volt apparatus is near at hand to enable simultaneous comparison to be made. It may, therefore, be mentioned that a group of three single-phase transformers for 100,000 volts would occupy practically the same space. The sister machine which has been retained at Preston for further experiments and tests to be carried out, is the receiving member of the pair. It is designed to take in 100,000 volt direct current, and to give out 2,000 kw. of three-phase alternating current at 3,000 volts and 50 cycles, and 100 per cent. power factor. The driving motor is purposely made much larger than is required to drive the brush gear, in order that it may serve to correct the power-factor of the 3,000 volt alternating current network. Instead of using six three-phase transformers as in the experimental Transverter, the Wembley machine is provided with three six-phase transformers, which are housed in the metal tanks seen in the illustrations. The cylinder at the top is an oil-reservoir whose function it is to compensate for the expansion and contraction of the oil with changes of temperature, while at the same time preventing the access of air to the oil. Such an arrangement is typical of the English Electric Company's practice in the case of all large oil-filled transformers.

At one end of the machine will be seen the series of stationary commutators with the motor-driven brush gear. Figs. 12 to 17 on Plates LV and LVI illustrate the construction of the 2,000 kw. Transverter somewhat more fully. The six-phase transformer units are arranged side by side so that all the windings and connections are accessible. The commutating unit, which was mounted on the top of the tank on the experimental machine, is now placed on a separate foundation at the end of the tanks. There are ten commutators, and there is no central neutral earthed point on the direct current side, the machine being designed to stand the full pressure of 100,000 volts to earth. The secondary winding is a two-circuit wave winding with a six-pole connection, and the brush speed is, therefore, 1,000 revolutions per minute. The appearance of the machine, as erected in the English Electric Company's works at Preston, but with the transformer tanks removed, is shown in Figs. 12 and 13. The core of one of the transformers, complete but without the windings is shown in Fig. 11, page 565. In Fig. 14 is illustrated the bedplate and lower portion of the oil tank before any of the electrical apparatus was in position. The shaft carrying the ten sets of commutator brushes is shown in Fig. 15, and one of the commutators in Fig. 16. These, as in the experimental machine are of the disc type, and consist of a circle of commutator bars arranged radially on the face of a slab of insulating material. Fig. 17 shows a view of the commutators complete and in position, but with the shaft and brush gear removed. The synchronous motor which drives the brush gear can be seen at the far end.

It may be mentioned that extra high tension transmission by means of Transverters permits the alternating current delivered by the machine at the receiving end of the line to be at a frequency different from that of the original source of supply. Each Transverter would be designed to suit the voltage and frequency of its own alternating-current system and no other change would be necessary. Thus, for example, a 50-cycle system could be interconnected with a 40-cycle system and power sent in either direction, without the intervention of a frequency changer or any other apparatus.

Credit should be given to the directors of the English Electric Company, Limited, for their courage in undertaking the bold and costly experiments which have resulted in the machine exhibited. Instead of adopting the timorous practice of waiting for something to be developed abroad and then acquiring a license to make it, a method of keeping behind other nations which is very harmful to our engineering prestige in foreign countries, they were content to rely upon the ability and experience of their own staff. By so doing they have registered a notable advance in electrical engineering, the development of which will be watched with the utmost interest.

INTERNATIONAL CEMENT CONGRESS.

(*Concluded from page* 557.)

WE conclude our report of the Cement Congress held in London on the 22nd inst.

The effect of changing the viscosity of slurry by the addition of chemicals was discussed in a paper presented by Messrs. J. W. Christelow and E. Bowes. This was based upon work carried out by the authors for the British Portland Cement Research Association, and has already been referred to in our columns, as the results were published in a recent Bulletin of the Association. The effect of adding sodium carbonate to certain slurries is to decrease the viscosity, thus making it possible to handle equally easily slurry containing less water than in common practice. The saving consequent upon this arises from a reduction of the fuel needed in clinkering. The authors gave as possible reductions of water 2·5 per cent. to 3 per cent.

Mr. Poullopidder spoke on the effect of calcium sulphate and sodium sulphate on clays. Five times as much sodium sulphate as calcium sulphate would be necessary to produce an equal degree of coagulation. If in clay in suspension calcium sulphate were replaced by sodium sulphate it would pass into a very fluid state, but as more sodium were added coagulation would increase. A similar action occurred with sodium chloride. The Medway clays contained the latter substance and were naturally coagulated so that soda did not act on them. Chalk slurry did not contain these salts and the addition of sodium sulphate made it more fluid.

Mr. Munro stated that the same effect was not secured with soda crystals as with soda ash. The saving depended upon the cost at the moment of soda ash and coal. The authors had used a figure of 10*l.* per ton for soda ash. At the present time the quoted price was between 6*l.* 10*s.* and 7*l.* A further economy was mentioned by Dr. G. Martin, who pointed out that in addition to the smaller quantity of water in the slurry to be dealt with, the presence of soda ash lowered the actual clinkering temperature so that economy should ensue from this. The discussion on this subject was closed by Mr. H. K. Bamber, who said that in one works in which the system had been applied commercially the saving in water in the slurry was about twice the amount stated in the paper, but the average would be pretty near the authors' figures.

The succeeding paper on "New Laws in Connection with Fine Grinding" was by Dr. G. Martin and Messrs. C. E. Blyth and H. Tongue. The principle enunciated was that in grinding, the particles increased in number at compound interest, and the authors considered that it would in the future become possible to estimate closely the amount of work necessary to secure any degree of fineness under given conditions, so that engineers would have something definite to work on, and others would be in a position to know when they were getting what they should out of their machines. Mr. Panisett said that if very much finer grinding was resorted to, the cements might well become so delicate that they would have to be used within 24 hours, and they would hardly be fit for storage. Cement stored in a shed would not keep in this country as it absorbed moisture which was always present in the atmosphere. These questions would become increasingly important with finer grinding.

A paper on "Structural Steelwork Reinforced with Concrete," by Mr. E. S. Andrews, was next discussed. The paper dealt with light frameworks of rolled sections encased or filled with concrete, and proposed the development of the concrete protective casing for resisting the effects of fire, &c., into an integral stress-carrying part of the composite structure. The author instanced the Gray type of column used in the United States and composed of four angles back to back, filled with concrete. This gave an increase in strength of 40 per cent. above the unfilled column. Plain fireproofed columns with 2-in. casing carried 50 per cent. more load than plain steel columns. Mr. H. J. Deane said the idea embodied in the paper did not appeal to him at all. It seemed to him that if a steel structure were to be built to be reinforced with concrete the whole design would have to be altered. In one example of encased steelwork with which he had acquaintance, the steel work consisted of H beams and channels. The slightest contact of a vessel with this structure separated the two materials. He did not see how the bond was to be maintained. With the angles of ordinary joists and rolled members it was impossible to expect a good keying with concrete. He did not think there was a very large field for the idea. Mr. H. Forchhammer did not agree with Mr. Deane, but designs must naturally be adapted to the purpose in view. With big members the application of the system might be difficult; with smaller members it was not so hard to apply satisfactorily. Bonding might in some cases be arranged by making holes in the webs. In the case of trusses the construction could be reinforced with concrete effectively, while there were cases in which old steelwork had to be strengthened, and this was possible with concrete, inserting reinforcing bars to improve the tension members.

Mr. Mitchell Moncrieff thought there was a good field for the system. He referred to the Redpath-Brown testing machine at the National Physical Laboratory, described in the issue of ENGINEERING of October 20, 1922 (page 484), and said that some of the results obtained with this, on steel members reinforced with concrete, were suggestive of the fact that there was something to be done on the lines suggested by Mr. Andrews. Among tests carried out, steel joists 4 in. by 3 in. and 16 ft. long were tested, in one case plain, and in the other encased so that the measurements were about 8 in. by 7 in. The naked joist failed at 4 tons, while the coated joist carried, if he remembered rightly, between 45 tons and 50 tons. He thought some practical results would probably follow.

There next followed three papers, taken together, on the new high alumina cements. One of these was by M. T. J. Guéritte and was entitled "Aluminous Cement in Practice." The second was by Professor A. Paris on "Aluminous Cement ('Ciment Fondu'), Pure or Mixed (Sand Cement)"; the third being by M. J. Bertet on the "Influence of the Quantity of Mixing Water on the Heating during the Hardening of Aluminous Cements." M. Guéritte limited his paper to practical matters, omitting chemical questions and manufacture. His firm had used a great deal of the cement, and from a number of tests made for them in various laboratories he had abstracted the following averages:—For neat cement, average tension, lb. per square inch, 627 at 1 day, 833 at 2 days, 877 at 3 days, 895 at 1 week, 1,027 at 4 weeks, 1,360 at 12 weeks. For compression the figures were: 6,733 at 1 day, 7,739 at 2 days, 9,340 at 3 days, 9,596 at 7 days, 12,125 at 28 days. For sand cement 1 : 3 mortar the average compression figures were: 3,528 at 1 day, 5,166 at 2 days, 5,456 at 3 days, 5,893 at 7 days, 6,671 at 28 days, 8,900 at 12 weeks. Tests of reinforced beams, slabs and columns had been carried out at the Conservatoire des Arts et Métiers, Paris, and cubes of the Lafarge Ciment-Fondu used of approximately 4 : 2 : 1 concrete gave 4,600 lb. at 3 days, 5,150 lb. at 3 months, 5,230 lb. at 6 months, 7,008 lb. at 12 months. The aggregate was Seine screened gravel. Some very high figures had been obtained by Mr. L. T. Weaser, bridge engineer, Essex County. Tests carried out at the Laboratoire National des Ponts et Chaussées, Paris, had shown a steady increase in strength up to five years, at which a 1 : 1 : 3 concrete gave a final figure at this age of 9,695 lb. per square inch. M. Guéritte considered it conservative to use 1,400 lb. for the working stresses for aluminous cement concrete of 1 : 2 : 4 proportion, the L.C.C. allowance for this proportion being 600 lb. for P.C. concrete. For a 1 : 3 : 6 concrete 1,000 lb. was probably within the limit. Until further information was available, however, the author recommended 1,300 lb. and 900 lb. for the two grades of mixture.

With regard to the effect of frost and low temperature, experiments in the Alps in 1922–23 had shown that blocks made in a room at 32 deg. F., falling to 14 deg. F. at night and 48 hours

after making immersed in water at 6 deg. F. and kept there for two years, remained perfect. If mixed above 32 deg. F. the temperature did not fall below 32 deg. F. before initial set took place, and thereafter the heat given out kept the temperature high enough for hardening to follow normally. Tests by Mr. Weaser in Essex during the recent winter showed that the increase in strength was somewhat retarded in severe weather, but remained sufficiently good to offer advantages; if the materials were above 32 deg. F. frost was immaterial. Messrs. Brims and Co., Limited, London, had carried on work throughout the hard frosts of the past winter. With concrete of the same richness shrinkage appeared to be the same as with P.C. concrete. With the poorer mixtures possible with Ciment-Fondu concrete, the shrinkage was slightly less. Practically the whole shrinkage took place in the first few days. The concrete was immune from attack by sea water or by sulphurous water. Blocks immersed in sea water, in water saturated with gypsum and in a 12 per cent. solution of sulphate of magnesium, in 1908, are still intact. Many oils appeared to have no effect upon it, but it was liable to attack by acids. Piles had been driven in Essex 41 hours old. There was likely to be a big field of application for it.

The paper by Prof. A. Paris dealt particularly with two applications of Electro-Ciment manufactured by the Compagnie de la Fonte électrique at Bex, Switzerland. One case was the repair of the Magnacun Tunnel on the Rhaetian Railway, in the Grisons, and the second was the construction of a reinforced concrete floor and pilework for a gasometer at Villeneuve, Vallais. The Magnacun Tunnel was completed between 1909 and 1913, but immediately began to give trouble, due to the destruction of the mortar used. Water present was found to contain considerable quantities of sulphates, especially of calcium sulphate. It was found that dense Portland cement concrete was little affected by these waters if it had sufficient time to set and for part of the work, by means of elaborate pumping arrangements, it was found possible to ensure this. In November, 1921, where rapid progress of construction was essential, owing to intense earth pressures, aluminous cement was tried with very excellent results. The immunity of attack from the water encountered and the rapid hardening, so that loading could be applied quickly, met the requirements of the case exactly. In the second case, a reinforced-concrete gasometer floor was built on piles, extending 10 metres into soft ground. The level of the sub-soil water fluctuated nearly two metres. The piles were of wood, the upper portions above lowest water level being protected with concrete. A dense concrete was desired, but was estimated to be too expensive, and a sand-cement mixture of 40 per cent. aluminous clinker and 60 per cent. sand was employed, and no trouble was experienced in driving the piles so coated after hardening. If the resistance to crushing of aluminous cement mortars proved too high for a particular purpose, sand-cement mortar could be considered, of a quality sufficient to meet the case, giving excellent density at a lower cost. The speed with which such a mortar hardened was not greatly different from that of the pure aluminous cement. These cements appeared to benefit even more than Portland cement by maturing under damp conditions, and were, therefore, specially suitable for underground and foundation work.

The paper by M. J. Bertet recorded the results of an investigation into the exothermic reactions accompanying the hardening of aluminous cements. The cement used was Electro-Ciment manufactured at Bex. It was found that the highest reaction temperature recorded was 94·40 C. at the end of 7 hours 23 mins., with 40 per cent. water. This was the shortest time in which the maximum temperature occurred for all percentages of water tested —from 20 per cent. to 110 per cent. The majority of the maximum temperatures were below 50° C. The resistance of the cement appeared to be quite independent of the heat of the re-actions in setting.

In inviting discussion on these papers, Mr. Bamber said he considered aluminous cement a good material for certain purposes. The best Portland cement, however, could attain in three or four days the results obtained with the other in four hours, and if three days were good enough, he thought Portland cement held the field. A contribution was submitted in writing by Mr. Weaser on the result of tests made in connection with his work on bridges in Essex. The figures all supported the claims which have been made for the material, and showed excellent results. On bridge work, on counterforts and wing walls, shuttering was removed in 18 hours, and on arch ribs, etc., after three days. It was important to avoid an excess of fine sand, which was liable to reduce the strength of the concrete considerably. Following this statement, Mr. Poullopidder remarked that the statements of Mr. Bamber regarding the best Portland cement did not agree with Danish experience, in which it had been found that Portland cement hardly reached in 28 days the strength attained by Ciment Fondu in 24 hours. Tested in the laboratory, however, Portland cement might show very high results. He would like to refer to the work of Mr. Bates in America on aluminous cements. Mr. Bates found that these cements, if set under water, had a considerably reduced strength. M. Bied had claimed that that was not so. He would like to know if, for instance, M. Paris had any figures for setting under water. In reply to this speaker's first remarks, Mr. Bamber admitted that the tests he referred to were laboratory tests which certainly did not always tally with practical results. With regard to the removal of shuttering, he knew in British Columbia of a case in which shuttering was removed in 48 hours with Portland cement concrete.

Major Smith said that if the strength of Ciment Fondu were really greater a saving would be effected in the case of buildings if the price were reasonable, as weight could be reduced. A warning was given by Mr. Moncrieff with regard to the claim made for immunity of attack from sea water. The same, said Mr. Moncrieff, had been urged forty years ago with regard to Portland cement, and he thought they should wait longer before admitting such a claim for aluminous cements. Mr. G. Berg said that one test of aluminous cement he had made showed a decrease in strength at one period, and he was anxious to know if that might be due to the high temperature of reaction. Very finely ground Portland cement would be found to have as high a strength in two days as that attained by Ciment Fondu. In the future, perhaps, they would get still finer Portland cements at a lower cost than Ciment Fondu. Mr. Cooper spoke of having seen comparative strength curves made by a Swiss firm showing the line for Portland cement ultimately crossing the curve for Ciment Fondu. The high temperatures of reaction appeared to be unfavourable to reinforced concrete work owing to expansion of the bars and the difficulty of maintaining bond. Stability of the material in sea water had yet to be proved. If Portland cement were properly made and sufficiently dense and impermeable it was a satisfactory material for that class of work.

Dr. C. H. Desch thought they should await the results of some years of further experience. Thirty years or so ago Portland cement containing 63 per cent. lime would have been considered unstable, but it was not thought to be so now. The presence of aluminates in both Portland cement and Ciment Fondu did not mean that similar effects would follow with both materials, as these constituents were different in the two products owing to the different methods of manufacture. He thought it possible that with long exposure to sea water there would be some falling off in strength. He had seen curves of the type mentioned by Mr. Cooper, but with such very remarkable results being reported from Switzerland and France, he thought they should refrain for the present from dogmatising.

Mr. Panisett, who followed, said it was not fair to refer to the Bates tests in connection with Ciment Fondu. Bates was a pioneer investigator who had worked on a range of about seven cements of the type. The comparison should not be made between these experimental cements and Ciment Fondu as now manufactured. He thought the results obtained would act as an incentive to Portland cement makers and that their product would be made to acquire characteristics similar to those of Ciment Fondu. He would like to know how engineers were to detect inferior aluminous cement. Tests specially applicable to the material would have to be devised. The standard specification was of no service. He thought the interests of the users and the reputation of the makers both required that attention should be given to this point.

Mr. H. Forchhammer said that they could not afford always to be waiting, as some had suggested. It was necessary to act on information as it became available. At the present time everything pointed to the material standing well in sea water. He strongly advocated the use of Ciment Fondu where it was worth using. For instance, Potlrand cement piles could not be driven in two or three days, certainly not less than ten to fourteen days at the earliest. There was ample proof that Ciment Fondu piles would stand this treatment, while for such work the material had the advantage that short piles could be lengthened readily and the work continued without serious delay.

Mr. T. J. Guéritte said he spoke as, and his paper gave the experiences of, a user of the material, interested in reinforced concrete work. His firm looked only at the results, and did not trouble themselves as to how the cement was made. It was an interesting fact that numbers of their contractors were continually asking at the present time to be allowed to use Ciment Fondu where he had specified Portland cement. It might be merely a coincidence, but it was certainly remarkable that Portland cement tests had shown great improvement lately. Possibly manufacturers had been spurred on by the appearance of the new material. There was no doubt whatever that Ciment Fondu had become very reliable indeed and had now been so for 18 months or more. If Portland cement could be made to possess the same characteristics as Ciment Fondu there would be a hearty welcome for it.

In concluding the discussion Mr. L. Cadic said that not a day passed without inquiries being made with regard to Ciment Fondu. There appeared to have got abroad an opinion that the product lost strength after a time. The same opinion was current formerly with regard to Portland cement. It was quite unfounded. The evolution of a standard specification must of course come from engineers and users. It was not for manufacturers themselves to formulate one.

The last paper taken at the Conference (two or three being held over) was one by Mr. Thaddeus Merriman, of New York, dealing on general lines with Portland Cement. The author reviewed the present state of knowledge on various parts of the subject and indicated lines of thought which he considered might be followed advantageously. The paper provoked no discussion, and with a vote of thanks to the Chairman the meeting terminated.

BENEFICIATION OF IRON ORES.—A study of iron ore beneficiation is being made by the U.S. Department of the Interior, through the Bureau of Mines. Magnetic concentration is being investigated to extend its application to deposits not now treated by this agency. A problem that has continued to receive the attention of the Bureau of Mines, with co-operating agencies, such as the universities of Alabama and Minnesota, and which is now well under way, is that of concentrating the high-silica iron ores (low-grade hematite), or the red ores such as are available at Birmingham. Experiments have been conducted to reduce the burden on the blast furnace and increase its capacity by a preparatory treatment by concentration. The present tests are being conducted at the University of Alabama. The treatment given is by means of jigs and concentrating tables, these being compared with other methods, such as magnetic concentration. Tests by magnetic concentration, roasting and agglomeration have been made, with promising results in some cases, while in others possibilities are looked for. It is believed that a thorough study of the brown ores of Tennessee will repay manifold the cost of investigation, having in view the betterment of methods for preparing iron ores for the blast furnace. The experiments reveal the fact that it is possible to produce clean ore and low-grade tailings in the form of jig products in many instances and at sizes as coarse as ½-inch. Fine grinding is sometimes found to be necessary to permit of the required separation. During crushing, the iron minerals being more brittle than the gangue, means will have to be devised to effect a proper reduction of the ore. Table concentration is expected to be required for the finer sizes and magnetic concentration for the others. Improved magnetic concentration has been rendered possible through development of a special separator. The possibility of improving the preparatory treatment of the many high-silica ores for blast-furnace smelting is felt most urgently in the South-Eastern States, where fuel, flux, transportation and labour are favourable for a still higher development of the iron industry. It is hoped to render it economically possible to raise the iron content of some of these ores from 35 per cent. to 45 per cent., or higher, and reduce the silica from 19 per cent. or thereabouts to 8 per cent. or lower.

THE GREAT LAKE HYDRO-ELECTRIC SCHEME, TASMANIA.

(*Continued from page* 452.)

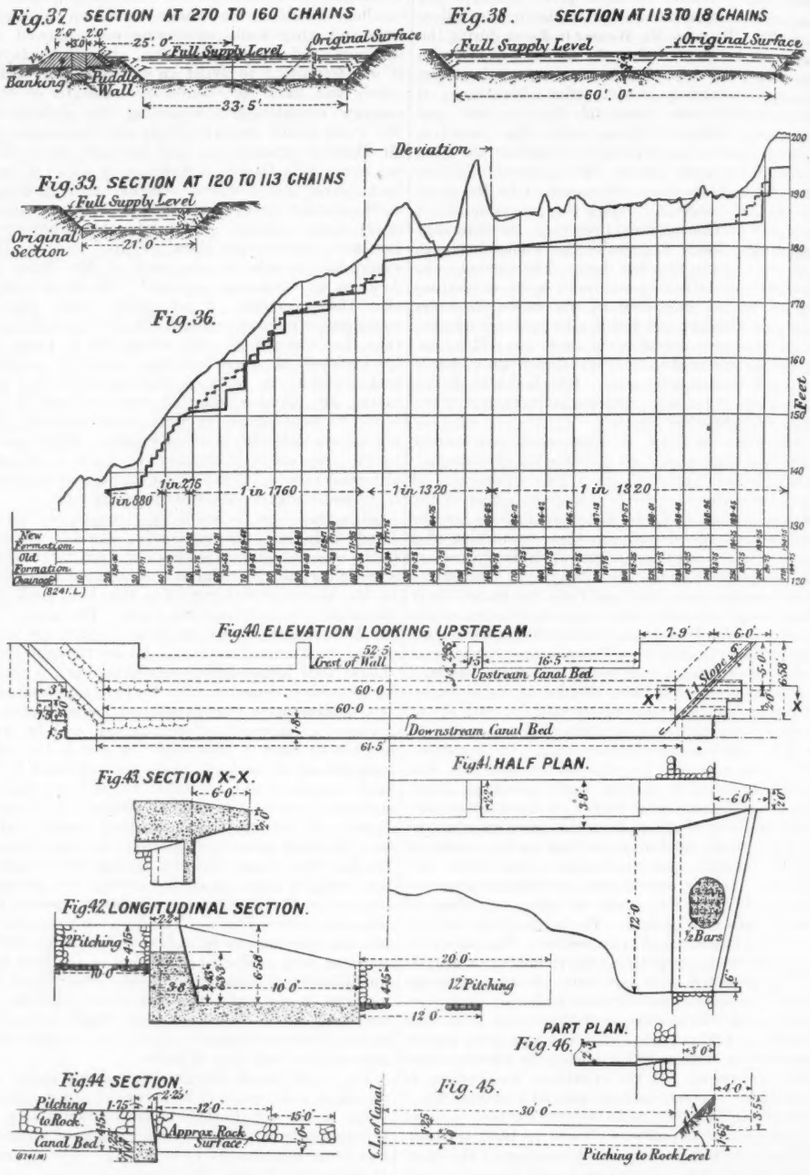
THE water from the Great Lake flows down the River Shannon for a distance of about 4 miles, at which point a low overshot rock fill weir diverts it into the power-house canal. The canal, which is 3½ miles in length, was originally constructed to carry 280 cusecs, and having a comparatively steep fall was broken at intervals by a series of small pitched drops. With the extension of the scheme it became necessary to increase the capacity of the canal to 600 cusecs. To accomplish this the canal was regraded throughout to approximately 4 ft. per mile and deepened and widened where necessary. In regrading the canal the original drops were for the most part removed and the surplus head concentrated in a smaller number of concrete drops. A profile of the canal is given in Fig. 36, the full line showing the new, and the dotted line the old lay-out. The new and larger concrete drops are those between chains 62 and 270. Drawings of a typical drop are given in Figs. 40 to 43, annexed, the design being standard but the dimensions varied to suit the various sites. Figs. 55 and 56, Plate LVII, show two typical stretches of the canal in which several of these drops occur. Figs. 44 to 46 show the type of baffle wall used on the lower part of the canal. At the upper end the new canal is 33 ft. wide on the bottom, with 1 to 1 slopes, and carries 5·5 ft. of water, a section on the upper stretches being given in Fig. 37. At the lower end it is 60 ft. wide on the bottom with 1 to 1 slopes and carries 3 ft. 4 in. of water, as shown in Fig. 38, changing at chain 113 to the section shown in Fig. 39. The widening of the canal had to be carried out without interrupting the flow for more than a few hours at a time. A narrow bank was therefore left in the centre, which allowed of the bulk of the excavation being done under comparatively dry conditions. Scoops were employed largely, and after completing this portion of the excavation the central bank was gradually removed by barrows during short periods when the water could be shut off. One section, 50 chains in length, consisted mostly of solid rock, and the procedure adopted for widening the other portions of the canal could not be employed here, owing to the risk of completely blocking the canal when blasting. For this section, therefore, a second canal was excavated on a deviation, the work being carried out in the dry, except for the actual connection at two ends to the old canal. The position of this rock section deviation is shown in Fig. 36. The intake to the canal is controlled by hand-operated timber sluice gates, immediately below which the water passes through an enclosed trash rack of steel rails. The quantity of material excavated in enlarging the canal was 166,000 cub. yards, and 5,000 cub. yards of concrete and masonry were placed in the drops.

The canal discharges into a natural depression known as the "Lagoon" (see Fig. 2, page 355 *ante*), which, by means of three low earth banks, 3,500 ft. in length, has been converted into an artificial pipe-head reservoir, having an area of 360 acres and an average depth of 3 ft. to 4 ft. The existence of this balancing reservoir, already partly constructed by nature, is an important feature of the scheme, because it permits of considerable fluctuation in load without changing the flow in the canal, and renders it possible entirely to shut off the canal for short periods for repairs. The lagoon is provided with a short spillway, which enables surplus water to be discharged directly into the Ouse River if necessary. The water level in the lagoon is 3,005 ft. above sea level, and 1,120 ft. above the nozzles of the Pelton wheels at the power station.

The penstock chamber is situated at the southern end of the lagoon, and consists of two approximately similar cubical box-like structures of reinforced concrete. In the front wall of each chamber is a series of lifting gates for regulating the admission of water from the lagoon, and in the back wall two bell-mouthed inlets in each chamber to pass water to the four pipes, which are controlled by one 48-in. and three 60-in. butterfly valves. Each chamber is provided with a scour valve and is roofed over to prevent rubbish from gaining entrance to

HYDRO-ELECTRIC SCHEME, TASMANIA.

MR. J. H. BUTTERS, M.I.E.E., ENGINEER.



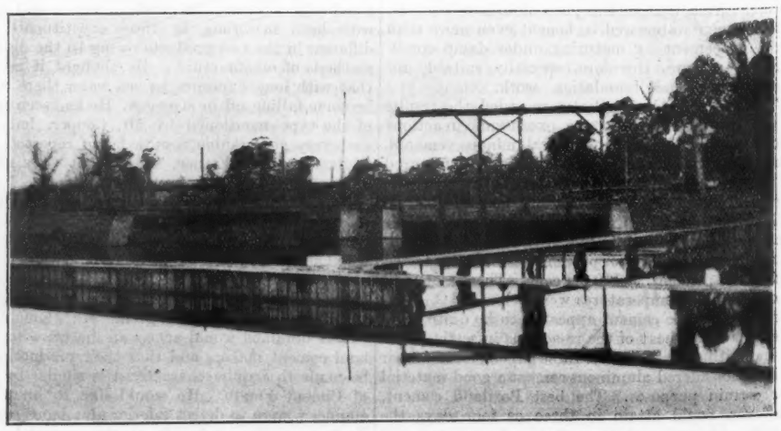


FIG. 47. FOREBAY AND PENSTOCKS.

THE GREAT LAKES HYDRO-ELECTRIC SCHEME, TASMANIA.

MR. J. H. BUTTERS, M.I.E.E., ENGINEER.

Fig. 48.

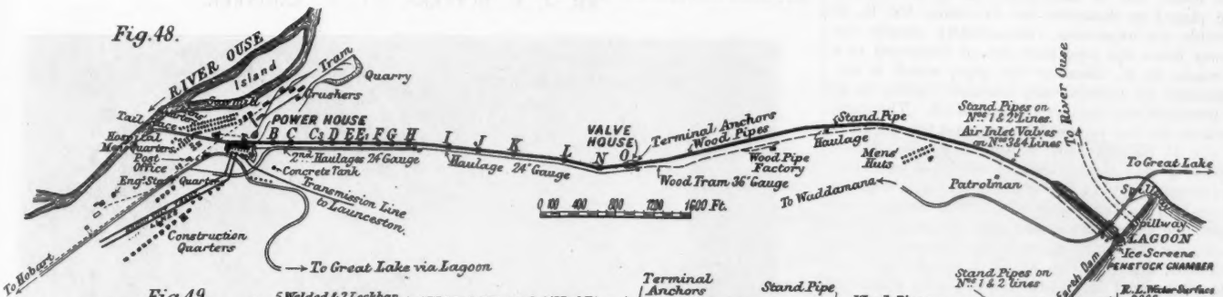


Fig. 49.

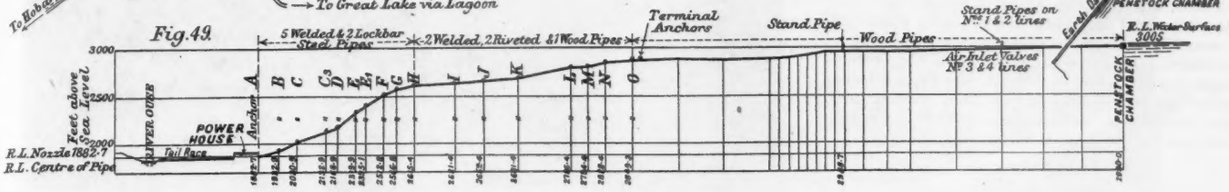

5 Welded & 2 Lockbar Steel Pipes
2 Welded, 2 Riveted & 1 Wood Pipes
Terminal Anchors
Stand Pipe
Wood Pipes
Stand Pipes on Nos 1 & 2 lines
Air Inlet Valves No 3 & 4 lines
Earth Dam
R.L. Water Surface 3005
PENSTOCK CHAMBER
Feet above Sea Level
3000
2500
2000
RIVER OUSE
POWER HOUSE
Tail Race
Anchors A B C C3 D E E1 F G H J J1 K M M1 N O
R.L. Nozzle 1882·7
R.L. Centre of Pipe

Fig. 50.

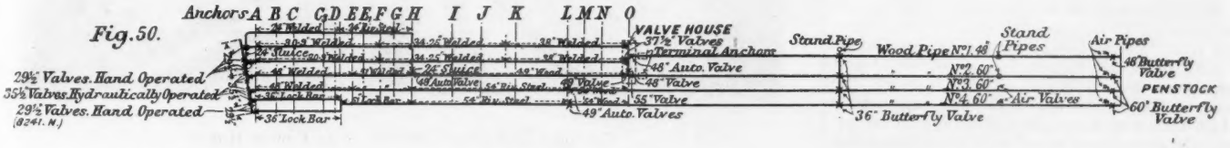


Fig. 51. ELEVATION (SECTIONAL)

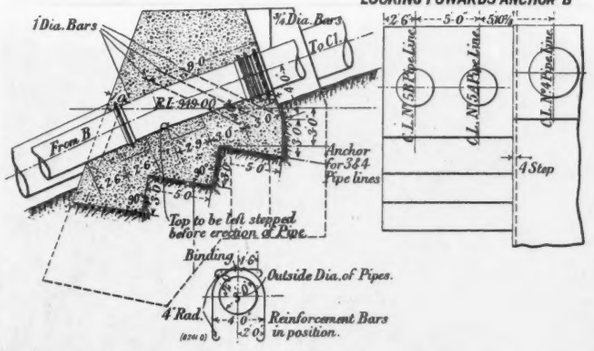


Fig. 52. END ELEVATION LOOKING TOWARDS ANCHOR "B"

the pipes. In front of the inlet gates sliding screens are installed, and gear, suitably housed for winter operation, is provided for lifting and cleaning them. During severe winters a considerable quantity of ice forms on the lagoon. A fender has been constructed to prevent the ice from blocking the entrance to the penstock chambers. This fender consists of timber piles supporting vertical sheeting extending several feet below water level, and it is so placed as to direct the movement of ice away from the chambers. Fig. 47, on the opposite page, shows the lagoon and penstock chambers controlling the flow to the pipe lines.

The length, measured on the slope, from the penstock chamber to power-house, is 9,650 ft. A profile, Fig. 49, above, gives the distances and fall from the lagoon to the power station, the plan Fig. 48 showing the general lay-out of the system, while Fig. 50 gives particulars of the pipe lines themselves. The original installation comprised one 48-in. continuous wood stave pipe, which extends for a distance of 5,500 ft. from the penstock chamber, at which point the static head is 150 ft. This pipe branches into two welded steel pipes running to the power-house, composed of three sections of equal length having diameters of 38 in., 34·25 in. and 30·9 in., respectively (see Fig. 50). The next extension was the laying of No. 2 wood pipe, 60 in. in diameter, and of the same length as No. 1 wood pipe. Owing to war conditions, large steel pipes could not be obtained nor was material available for their manufacture in Australia. To meet the immediate demand for power, therefore, No. 2 wood pipe was reduced to 49 in. diameter and continued a further distance of 2,300 ft. to a point where the static head becomes 400 ft. This is probably the highest head under which wood pipes of such large diameter have been utilised. For the remaining distance of 1,850 ft. to the power-house, under a head varying from 400 ft. to 1,100 ft. steel pipe was essential, but the largest pipe which could be manufactured in Australia was a 24-in. diameter riveted steel pipe, and this was installed to meet the immediate power demand. As soon as it could be obtained a welded steel pipe was laid parallel with the 24-in. riveted line. This pipe was 51 in. diameter for the upper portion of its length, reduced to 48 in. lower down.

To complete the extension of the scheme two more 60-in. wood pipes were laid for 5,500 ft. from the penstock chamber. They were then reduced to 54 in. wood pipe for a further distance of 640 ft., and were continued as 54 in. riveted steel pipes for another 1,660 ft. to the 400 ft. head point adjacent to the end of the high-pressure wood pipe. From this point to the power-house, a distance of 1,850 ft., there is another 51 in. to 48 in. welded steel pipe, and also one 51-in. lock bar steel pipe branching into two 36-in. lock bar pipes. The two original welded lines and two later 51 in. to 48 in. welded lines were supplied through Messrs. Boving and Co., of London, and the 24-in. line and the other riveted and lock bar pipes were manufactured in Australia by Messrs. Mephan, Ferguson Proprietary, Limited. Immediately below the butterfly valves at the penstock chamber each wood pipe has an 18 in. diameter stand pipe 10 ft. high to act as an air inlet, in order to prevent the collapse of the pipe when rapidly emptied. For the same reason automatic air inlet valves are placed at intervals on the wood pipes. At the down-stream end of each wood pipe is installed an automatic valve, which will close slowly in the event of a break occurring in any of the steel pipes lower down.

To prevent the occurrence of negative pressures arising from surges due to sudden variations of load on the turbines, a steel surge tower pipe, 15 ft. in diameter and 68 ft. high, is constructed at a point about 3,300 ft. from the penstock chamber. The surge tower and the four wood stave pipe lines on the upper section are well shown in Fig. 57, Plate LVII. From the surge tower a 48-in. riveted steel bus pipe runs transversely above the four wood pipes and is connected to each of them through a 36-in. butterfly valve.

The wood pipes, which were supplied and erected on prepared foundations by the Australian Wood Pipe Company, are built up of wood staves, machined to a segment of a circle and held together in the form of a pipe by long steel bands. The two ends of the bands are connected by a steel shoe and are tightened by screwing up a nut on the band against the shoe. Different styles of shoe have been employed, but a plate steel shoe recently developed is the most satisfactory. The spacing of the bands varies with the head on the pipe. The joints at the ends of the staves are staggered and are formed by butting the ends of the two staves together. In the case of the three earlier pipes, a saw cut about an inch deep was made in the end of each stave and a metal fillet driven tight into this slot renders the joint tight. In the latest pipe, tongue and groove joints were machined on the ends of the staves, and no metal fillet is employed. The pipes are laid entirely above ground and are supported on bed logs obtained near the site and adzed to the shape of the pipe on their upper surface. The 48 in. and the first of the 60 in. wood pipes were built of Douglas fir (Oregon), and the 49 in. high-pressure pipe and the two later 60 in. pipes were built of Powellised Karri, obtained from the W.A. Government Sawmills.

The steel pipes are supported on concrete piers and are encased in heavy concrete anchors at

each bend, as illustrated in Figs. 51 and 52, which show anchor C of Fig. 50. In addition to this massive terminal anchors have been built at the lower end of each pipe. Long muff joints are placed at distances not exceeding 100 ft. to provide for expansion. Immediately outside the power house the pipe lines are all connected to a common 36 in. diameter bus pipe, which is sectionalised by hydraulically-operated valves, so as to permit of any one pipe being shut off. The static head on the bus pipe is 1,120 ft., and the thickness of the 48 in. pipes just before they join the bus pipe is $\frac{11}{16}$ in. A good view of the pipes on one of the steeper parts of the grade is given in Fig. 58, Plate LVII, This shows two 54-in. riveted steel pipes, one 49-in. stave pipe, and two 38-in. welded steel pipes, the arrangement of pipes between anchors H and O, Fig. 49. Fig. 53, on this page, gives an idea of the final drop to the power house, which can be seen 750 ft. below the point from which the view was taken. The pipe arrangement of the bottom stages is well shown in Fig. 54, the supply being finally distributed between one 24-in. welded steel pipe, two 30·9-in. welded pipes, two 48-in. welded lines, and two 36-in. lock bar pipes.

(To be continued.)

COLOURS, STAINS AND DYES.

OUTLINING modern views on colours and dyeing in his Royal Institution discourse on "Colours, Stains, and Dyes" on April 11, Professor Jocelyn Thorpe, F.R.S., of South Kensington, stated that most substances were colourless. This included also most of the 300,000 known carbon compounds to which 4,000 were being added annually. A colourless substance showed no selective absorption either in reflected or transmitted light; but there might be absorption in the invisible ultraviolet. Thus benzene, which appeared to be quite colourless, strongly absorbed light in the ultraviolet and was, in a chemical sense, intensely coloured. Nature made little use of the chemical colours of carbon compounds. The brilliant reflection-colours of birds, beetles, and butterflies were interference phenomena and the light of the lantern beam passing through a butterfly wing or a peacock feather, Professor Thorpe showed, was colourless. A pigment had, however, recently been extracted from the wings of certain parrots, and was found to contain copper; metallic oxides were the chief pigments of nature but flowers and plants contained other colouring matters. All organic colouring matters were unsaturated and, in a measure, unstable compounds; the instability was connected with the existence of unsaturated valencies (double bonds) between certain atoms. The ring molecule of benzene, though stable, had such double bonds and showed its unsaturation by readily forming additive compounds. When certain atomic groups, such as hydroxyl OH, amide NH_2, chlorine Cl, were introduced into the benzene ring, the absorption shifted from the ultraviolet into the violet and further to the red, the compound then assuming the colour complementary to the colour blocked out by the absorption. These synthetic colours, discovered by Perkin in 1856, differed from the old dyes also as to the mode of dyeing. In madder (alizarine) dyeing the fibre was first impregnated with a metallic salt (a mordant) which formed an insoluble coloured compound (a lake) with the dye. In the indigo (vat) dyes the colourless dye became oxidised and turned blue in the fibre. In the coal-tar colours which were salts, part of the molecule was taken up by the textile fibre, but was not so well retained as with the older dyes, and might be washed out again unless fixed in other ways.

Professor Thorpe distinguished these colouring matters which would not dye cotton by the term "stains." None of them were so fast to oxygen, chemicals, light, and age as the old mordant and vat dyes. The natural colouring matter of the rose and other flowers owed their fastness to being highly oxygenated in their molecules. The colloidal nature of the fibres probably played an important part. The chemical constitutions which conferred colour upon molecules were still controversial in spite of many triumphs of research.

HYDRO-ELECTRIC SCHEME, TASMANIA.

MR. J. H. BUTTERS, M.I.E.E., ENGINEER.

FIG. 53. THE FINAL DROP TO THE POWER HOUSE.

FIG. 54. THE LOWER SECTION OF THE PIPE LINES.

2,000-KW. TRANSVERTER FOR 100,000-VOLT D.-C. TRANSMISSION AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, PRESTON.

(*For Description, see Page* 563.)

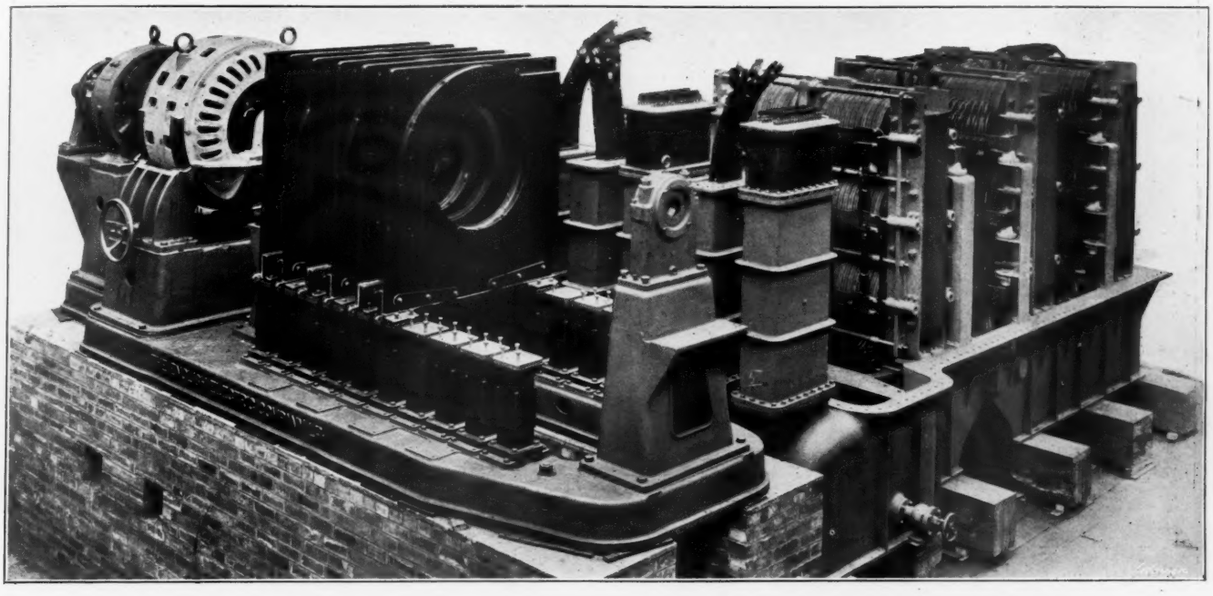


FIG. 12. VIEW OF MACHINE FROM COMMUTATOR END DURING ERECTION.

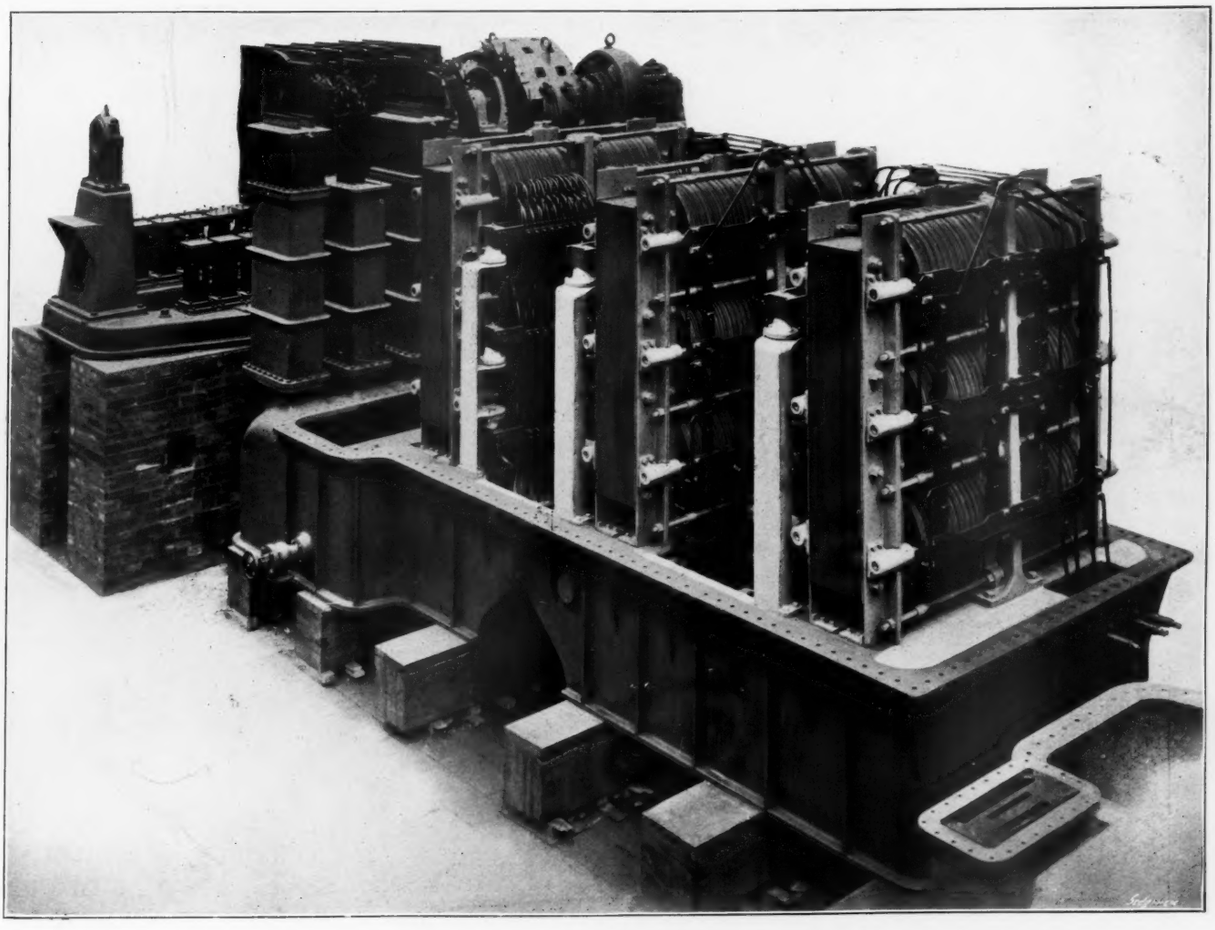


FIG. 13. VIEW OF MACHINE FROM TRANSFORMER END DURING ERECTION.

(*To face Page* 566.)

2,000-KW. TRANSVERTER FOR 100,000-VOLT D.-C. TRANSMISSION AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY THE ENGLISH ELECTRIC COMPANY, LIMITED, ENGINEERS, PRESTON.

(*For Description, see Page* 563.)

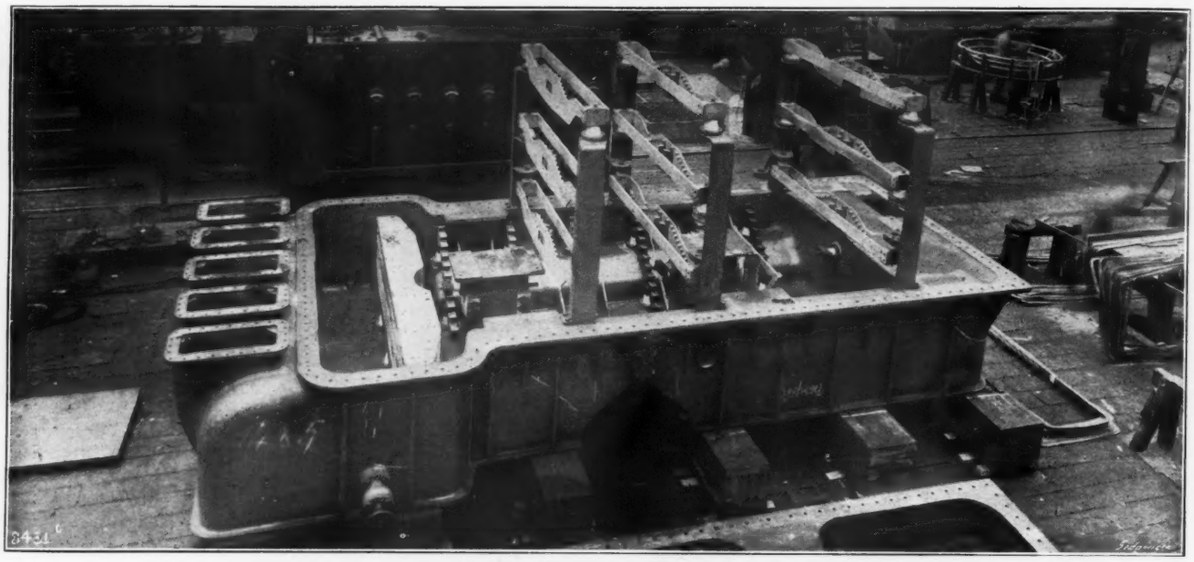


FIG. 14. BEDPLATE OF MACHINE.

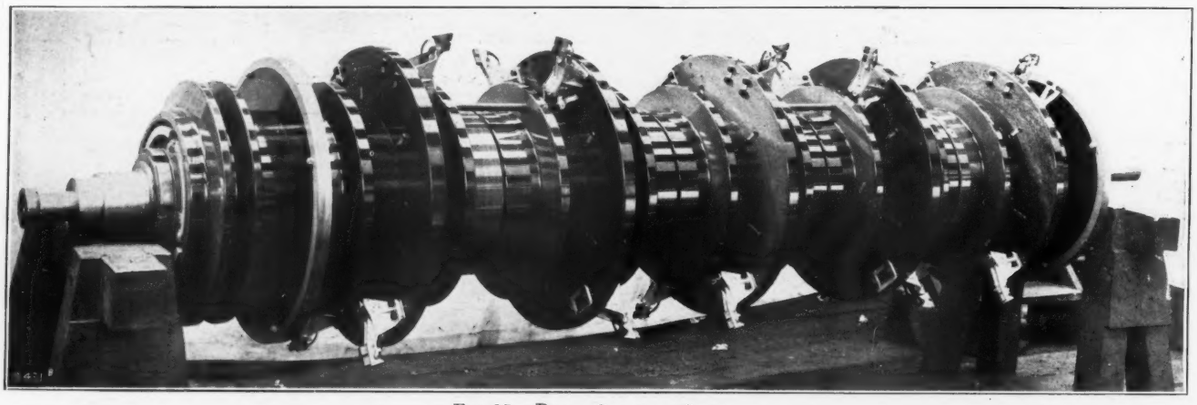


FIG. 15. BRUSH GEAR AND SHAFT.

FIG. 16. ONE OF THE COMMUTATORS.

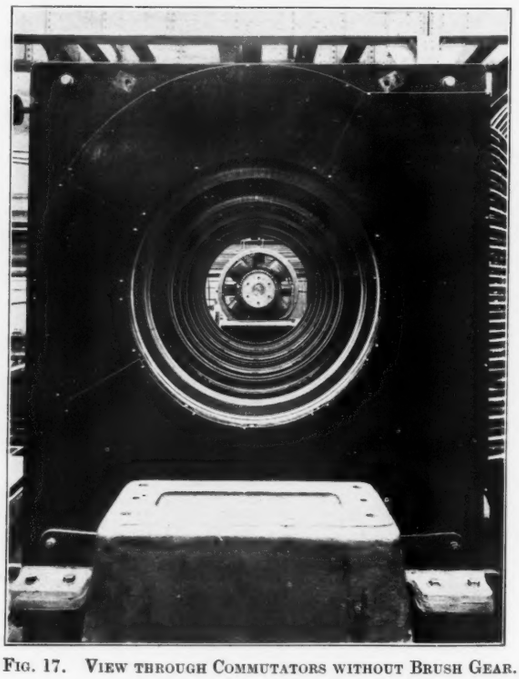


FIG. 17. VIEW THROUGH COMMUTATORS WITHOUT BRUSH GEAR.

(*To face page* 567.)

THE GREAT LAKE HYDRO-ELECTRIC SCHEME, TASMANIA.

MR. J. H. BUTTERS, M.I.E.E., CHIEF ENGINEER AND GENERAL MANAGER, HYDRO-ELECTRIC DEPARTMENT, TASMANIA, ENGINEER.

(*For Description, see Page* 568.)

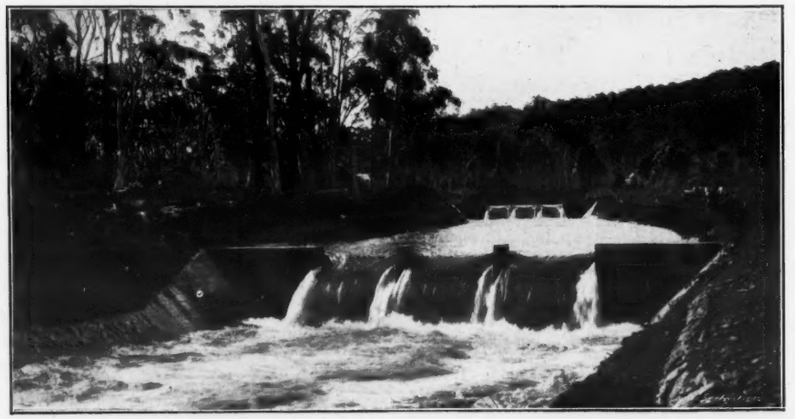


FIG. 55. WATER DROPS ON UPPER PART OF WADDAMANA CANAL.

FIG. 56. WATER DROPS ON LOWER PART OF WADDAMANA CANAL.

FIG. 57. WOOD STAVE PIPE LINES AND SURGE TOWER.

FIG. 58. TWO RIVETED, ONE WOOD STAVE, AND TWO WELDED STEEL PIPE LINES.

(*To face page* 570.)

NORMAND BOILER FOR THE FRENCH TORPEDO BOAT "ENSEIGNE GABOLDE."

CONSTRUCTED BY THE CHANTIERS ET ATELIERS AUGUSTIN NORMAND, SHIPBUILDERS AND ENGINEERS, HAVRE.

(For Description, see Page 571.)

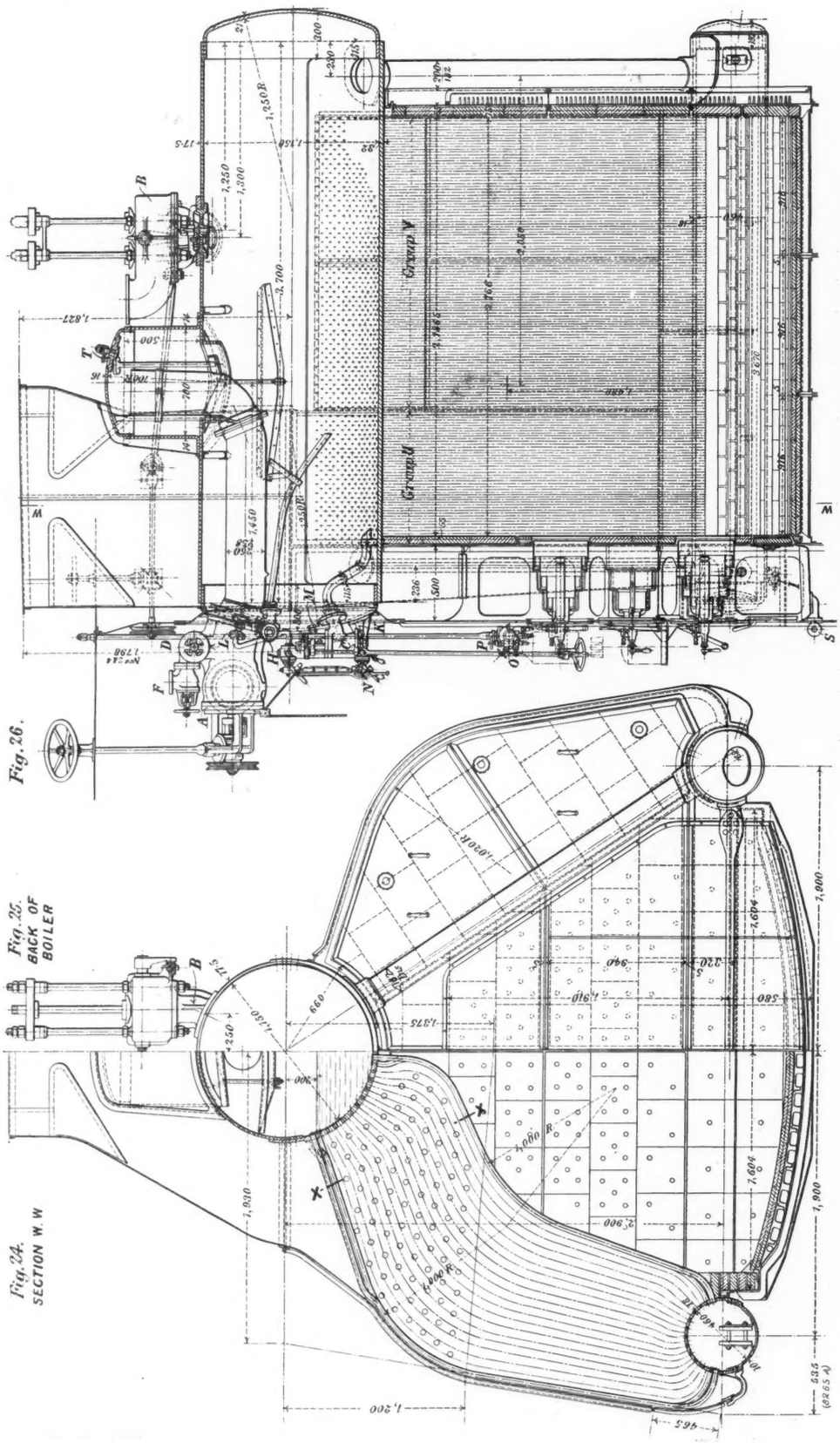


Fig. 24. SECTION W. W

Fig. 25. BACK OF BOILER

Fig. 26.

(To face Page 571.)

NORMAND BOILER FOR THE FRENCH TORPEDO-BOAT "ENSEIGNE GABOLDE."

CONSTRUCTED BY THE CHANTIERS ET ATELIERS AUGUSTIN NORMAND, SHIPBUILDERS AND ENGINEERS, HAVRE.

Fig. 19. BOILERS 1 & 4.

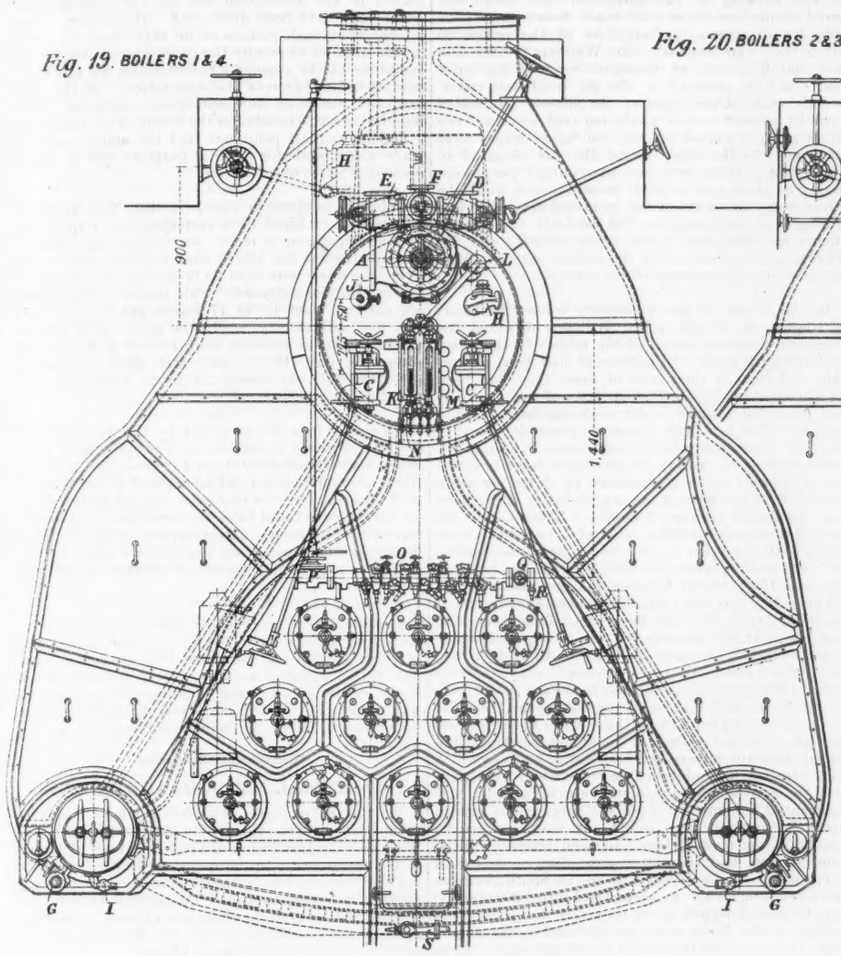


Fig. 20. BOILERS 2 & 3

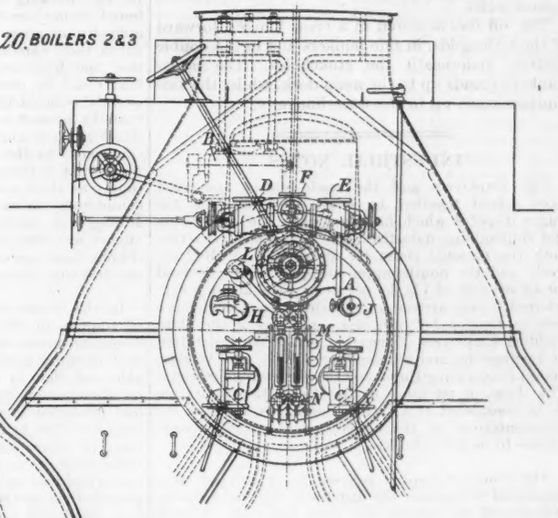


Fig. 22.

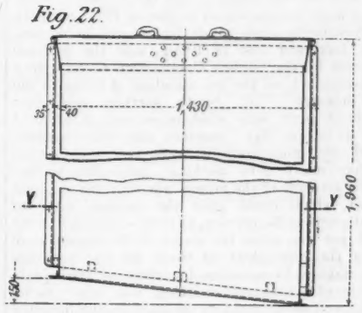


Fig. 21. SECTION X.X. (*Fig. 25*)

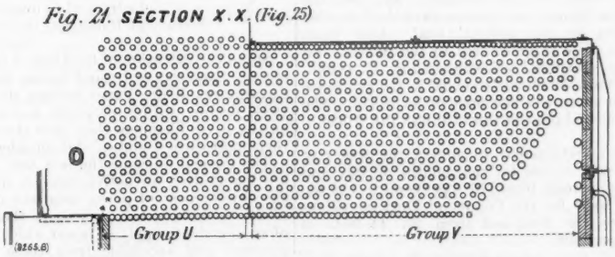
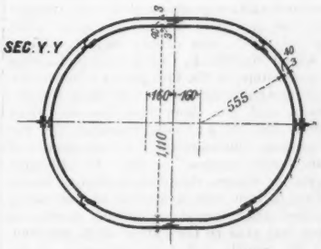


Fig. 23. SEC. Y.Y



THE FRENCH TORPEDO-BOAT "ENSEIGNE GABOLDE."

(*Concluded from page* 486.)

THE turbines of the Enseigne Gabolde are supplied with steam from four oil-fuel fired boilers. The boilers are illustrated in Figs. 19 to 26 above, and on Plate LVIII. Figs. 19 and 20 show the front of boilers 1 and 4 and 2 and 3; Fig. 21 details of the tube spacing; Figs. 22 and 23 the principal dimensions of the funnels; Figs. 24 to 26 a half cross section, a half rear end view and a longitudinal section of the boilers. The references to the illustrations are the following:—

A.—250 mm. (9·8 in.) main steam valve.
B.—148 mm. (5·8 in.) safety valve.
C.— 50 mm. (1·9 in.) feed regulator.
D.— 80 mm. (3·1 in.) steam supply valve to boiler-room auxiliaries.
E.— 80 mm. (3·1 in.) steam supply valve to engine-room auxiliaries.
F.— 60 mm. (2·3 in.) steam supply valve to ejectors.
G.— 30 mm. (1·1 in.) wash out cock.
H.— 30 mm. (1·1 in.) scum cock.
I.— 20 mm. (0·8 in.) blow-off cock.
J.— 20 mm. (0·8 in.) steam connection to pressure gauges.
K.— 20 mm. (0·8 in.) facing for gauge glasses.
L.— 20 mm. (0·8 in.) steam cock for gauge glasses.
M.— 6 mm. (0·2 in.) test cock.
N.— 8 mm. (0·3 in.) gauge glasses.
O.— 40 and 25 mm. (1·6 and 0·9 in.) oil fuel distribution chest to atomisers.
P.— 40 mm. (1·6 in.) cock for oil fuel supply to the latter.
Q.— 25 mm. (0·9 in.) petrol lighting-up valve.
R.— 25 and 10 mm. (0·9 and 0·4 in.) oil fuel supply pipe to distribution chest.
S.— 30 and 15 mm. (1·1 and 0·6 in.) ejector of central furnace trough.
T.— air inlet plug.

As shown in Fig. 4, on Plate XXXIII, of our issue of April 18, the four boilers and the auxiliary machinery are in two compartments which are in free communication with the deck. In front of each boiler is a plate partition through which pass the rods for operating the nozzles and burners. The forced-draught fan delivers in the rear of the plate partition, the fan insuring a maximum air pressure of 24 grammes per sq. cm. (9·4 in. water gauge). The fans draw above deck through ventilating cowls; a suction pipe fitted with adjustable air-flaps is also provided for drawing air from the stokeholds to facilitate the renewal of air and insure satisfactory cooling.

The boilers are of the Normand type; their principal dimensions and characteristic features are as follow:—

Total tubular heating surface		515 sq. m. = 5,543 sq. ft.
Number of small tubes	...	1,686
Number of large tubes	...	156
Diameter of small tubes	...	25 × 30 mm. = 0·9 × 1·1 in.
Diameter of large tubes	...	30 × 36 mm. = 1·1 × 1·4 in.
Average length of small tubes		3·194 m. = 10 ft. 5½ in.
Average length of large tubes		2·931 m. = 9 ft. 7 in.
Water capacity of the boiler		6,080 lit. = 13,400 lb.
Steam space		3,220 lit. = 114 cub. ft.
Pressure		17 kgr. = 241 lb. per square in.

Each boiler has 12 burners capable of delivering

250 kgr. (550 lb.) of oil fuel at a pressure of 12 kgs. (170 lb. per square inch) under the action of the fuel pumps. The pressure can be carried to 14 kgr. and 15 kgr. (199 lb. and 213 lb. per square inch).

The oil fuel is stored in a cross bunker forward of the stokeholds, in side bunkers and in the double bottom underneath the stokeholds. The cross-bunker extends up to the main deck, whilst the side bunkers reach up to the waterline only.

INDUSTRIAL NOTES.

THE employers and the trade unions concerned have agreed together to settle by arbitration the wages disputes which have arisen in the engineering and shipbuilding industries, the arrangement covering both the national claim for an advance of 10*s.* per week, and the Southampton shipyard men's demand for an advance of 17*s.* 6*d.* per week. The decision here referred to was arrived at following a joint conference held in London between representatives of the Shipbuilding Employers' Federation and of the Federation of Engineering and Shipbuilding Trades, the Amalgamated Engineering Union and the Shipwrights' Society. The terms of reference of the Arbitration Court are to be considered at a further conference between the representatives of the employers and of the trade unions to be held to-day.

The Court of Inquiry referred to in our last issue appointed to consider the dispute in the coal industry commenced its sittings last week-end. Mr. Herbert Smith, president of the Miners' Federation, in opening the case for the workers, said their claim was for "a living wage, a wage equal to that of 1914, with the local adjustments since made to remove anomalies, plus the increased cost of living, and the increase agreed upon by the Sankey Commission to raise to a more reasonable level the low standard of living in the mining industry." Mr. Smith further said that thousands of adult mine workers received a wage of only 5*s.* to 6*s.* per day; dustmen and other workers employed by municipalities were receiving higher wages than many mine workers. According to Mr. Smith, the attitude of the miners was that any national agreement which could give the owners such an abnormal profit as 2*s.* per ton, or even a standard profit of 1*s.* 5*d.* per ton, while the wages of the miners were less than the equivalent of those pre-war earnings that the Sankey Commission found to be inadequate for a reasonable standard of living, was unjust in its operation, and there could be no peace in the industry so long as it endured. Mr. Smith was satisfied that the capital invested in the mines and their equipment did not, to-day, on the average, exceed 10*s.* a ton on the output. On this basis, the agreement which gave 1*s.* 5*d.* per ton for standard profits and a total average profit of 2*s.* per ton in a year, when wages were below the cost of living mark, was clearly unjust. There was no need, added Mr. Smith, to sell coal in London to the ordinary consumer at 2*s.* 11*d.* per cwt., when the workers producing that coal cut it, set their timber, filled their trains and put them back for less than 3*s.* 6*d.* per ton. Mr. A. J. Cook, Secretary of the Miners' Federation, mentioned "a payment of 17,000,000*l.* in bonus shares"; this, he thought should have gone to wages, this distribution of bonus shares, according to him, was a method of concealing profit. He added that statistics showed profits to have been made last year to the extent of 26,500,000*l.* Mr. Cook, like Mr. Smith, called the attention of the Court to the number of casualties in mining work.

Mr. Evan Williams, President of the Mining Association, speaking on behalf of the owners, said there had always been two classes of workers, the piece-workers, who were paid on results, and the day-rate workers, who had a fixed amount per day, generally irrespective of the work they did. For the piece-worker, tonnage rates were fixed for the cutting of coal, and rates of payment for other classes of work. These rates became practically stereotyped, and except in cases where amendments had been made they had remained fairly steady right through the years. The tendency had been upward in all cases. The same could be said in regard to day rates. When the war came conditions became abnormal. Difficulties arose, the Government stepped in and variations took place by the addition of flat rates to piece-workers' and day-workers' wages. In regard to the Sankey Commission, Mr. Williams said its atmosphere was unreal and conclusions were arrived at hurriedly, without any real foundation. Following the strike of 1920, both sides met, said Mr. Williams, and agreed in principle that in future the wages to be paid should depend upon the ability of the industry to pay. Mr. Williams added that ample facilities for checking were afforded to the accountants of both sides; as a fact, they had visited practically every colliery. The agreement gave information to the miners to an extent unknown in any other industry in this or in any other country. In the working of the agreement the coalowners found themselves faced with heavy losses due to the difficulty of recouping themselves of the profits to which they were entitled. Mr. Williams further said that the high cost of transport reduced the price that could be obtained at the pit head and consequently reduced the wages of the miners. He added that the present cost of producing coal was due very largely, if not almost entirely, so far as wages were concerned, to the lesser hours. He was prepared to prove that if there were the same output per person to-day as there was in 1914, present wages would be considerably in excess of the increased cost of living. Mining work was hazardous, but the death rate among miners was less than in any other industry and, including fatal accidents, the death rate among miners was less than the average of the country.

In the course of his statements before the Court of Inquiry on Tuesday, Mr. Williams disputed the allegation made on behalf of the miners to the effect that earnings under the agreement had been deplorable and that in thousands of cases they had been on a starvation level. The earnings of the men who had presented themselves for work regularly had not been low, but had been higher in proportion to 1914 than in other competitive industries. No industry could show such a steady progression in the number of men employed or in the number of shifts per week provided for the men as the coal industry. The men now employed numbered nearly 1,190,000. Of the men who worked the full number of days the pits were open, 3·76 per cent. earned 35*s.* a week and under; 31,716 earned between 35*s.* and 40*s.*; 46,304 between 40*s.* and 45*s.*; 66,777 between 45*s.* and 50*s.*; 58,087 between 50*s.* and 55*s.*; 61,275 between 55*s.* and 60*s.*; 56,238 between 60*s.* and 65*s.*; 45,713 between 65*s.* and 70*s.*; 42,312 between 70*s.* and 75*s.*; and so on, there being 12,700 earning between 5*l.* and 5*l.* 5*s.*, and 2,000 earning over 8*l.* per week. In regard to about 1,000 men who were shown to earn under 20*s.*, Mr. Williams said that might be due to the fact that the men worked for two or three shifts only, because the pits were not open. It could not be denied, he added, that the miners had been earning wages which were sufficient to maintain a decent standard of living, and to increase the minimum rate of pay by any substantial amount would place a very serious burden upon the industry and would not work out to the benefit of the men. There had been severe competition to face, and there was great fear of American competition in the Mediterranean, in South America and elsewhere, for the Americans had added 200,000,000 tons to annual output, which they were doing their best to dispose of. If the terms put forward by the miners were the only ones that could be worked under, there would not be one out of every four collieries in the country that could continue working. Mr. Lee, the secretary of the Mining Association, gave the following figures relating to the miners' coal. Last year, 3,119,939 tons were supplied free to the miners, and 3,157,584 tons at special prices averaging 7*s.* 4·10*d.*, which meant that the miners received in the aggregate 6,277,523 tons at an average price of 3*s.* 8·47*d.* The average commercial price of this coal was 19*s.* 9·38*d.*

The wages ascertainment to govern the wages of the Durham coal miners for the months of May and June shows an increase from 116·6 per cent. to 122·01. The average wage for the County of Durham will, as a consequence, be increased from 9*s.* 11·96*d.* to 10*s.* 3·21*d.* per shift.

Mr. William Whitelaw, Chairman of the London and North Eastern Railway Company, has stated that the recent strike of locomotive enginemen cost his company 750,000*l.*, without a shadow of justification. He desired solidarity of labour to avoid divisional strikes and to establish a better code between capital and labour, but the belief that railway stockholders were millionaires was absolutely mistaken. In his company 90 per cent. of the stockholders owned on an average 820*l.* of stocks.

A decree, dated January 24, published in the Italian *Gazzetta Ufficiale*, placing the control of administration of the funds of workmen's associations under the local prefectures, has come into force in Italy.

All associations and corporations which draw their funds from workers' contributions with a view to mutual benefit are covered by the decree. Where there is ground for suspicion that the public confidence is being abused, or that the funds are being appropriated to uses other than the economic or moral benefit of the workers, the prefect may order an inquiry; and in grave or urgent cases may suspend the managing committee and appoint a commissioner to carry on the administration for a period not exceeding one year. A month before the termination of his appointment the commissioner must submit a report on the organisation of the association and on any irregularities which may have been discovered. The prefect, after interrogating such persons as he may think fit, shall decide whether to restore the control to the managing committee, or to appoint a commissioner for a further period, or to suppress the association. In the last case any assets of the association remaining after liquidation are to be used for the benefit of the members.

Italian journals point out that the employment of trade union funds for political purposes will be illegal under the terms of the decree.

Publicity is given in *The Iron Age*, New York, to information gathered by a correspondent, Captain G. L. Garden, during a recent journey through France. Captain Garden has stated that working shifts of 60 hours per week were soon to be started at the Nantes and St. Nazaire shipyards. Ship fitters in those yards are earning from 16 to 17 francs per day (at par, 12*s.* 10*d.* and 13*s.* 7½*d.*). In the shops, good men at machines and at erecting work receive as high as 20 francs per day (16*s.* at par) and when overtime is involved, very frequently 25 to 26 francs (at par, about 1*l.*) per day.

According to a decree issued by the Swiss Federal Council, Federal subsidies to unemployment relief works have ceased from April 1. From the middle of April, unemployment relief has ceased to be issued to part-time workers; subsidies to private undertakings are no longer granted from the same date; no further contributions towards unemployment relief are levied on employers; and trade associations cease to participate in the administration of unemployment relief funds.

The number of workpeople other than seamen reported as killed in the course of their employment in Great Britain and Northern Ireland during March was 231, distributed as follows:—In factories, work shops, docks, wharves and buildings, 90; in the railway service, 24; on tramways and canals, 3; in mines underground, 103; at mines, surface, 7; and in quarries, 4.

ELECTRICAL METHODS IN IRELAND.

WE give below copies of a correspondence which has taken place between the Government of the Irish Free State and the Institution of Civil Engineers of Ireland in connection with the proposed hydro-electric works in the Shannon, for which it is proposed that Messrs. Siemens Schenckertwerke of Berlin shall be both contractors and consulting engineers without competition of any kind. We criticised the scheme none too severely in our issue of March 14 last.

The Secretary,
Ministry of Industry and Commerce,
Government Buildings, Dublin.

March 24, 1924.

SIR,—The attention of the Council of the Institution of Civil Engineers of Ireland having been drawn to the Government White Paper bearing date February 26, 1924, dealing with a proposed hydro-electric scheme on the River Shannon, they have given this document their most earnest and careful consideration.

The Council welcome the fact that the Government are manifesting an active interest in a proposal for the development of power from the natural resources of the Free State, and they agree that the production of an abundant supply of power which would be cheap, constant and accessible from these resources is an object of the utmost importance to the well-being of the State and well worthy of the attention of the Government.

The Council, however, as representing the Institution which is deeply concerned in the preservation of the well-established principles of sound professional practice, deem it right to point out that the proposal, so far as its nature may be grasped from the internal evidence in the Government reply thereto, seems open to very grave objections.

If the Council have interpreted the purport of the White Paper correctly, it is apparent:—

(1) That the procedure proposed to be adopted is directly at variance with those principles of engineering practice which have heretofore governed the inception and execution of schemes of the kind whether promoted by individuals, corporations or governments. The Council submit that any departure from those principles must inevitably lead to results in the highest degree inimical to the welfare of the State.

(2) That it is proposed to endow an individual firm with the joint functions of promoter, consulting engineer and contractor, and this coupled with an apparent elimination of the element of open com-

petition with respect to prices. In the opinion of the Council, points such as these are in themselves sufficient to condemn the proposal, no matter how lavishly each of them may be fenced about with verbal safeguards.

(3) That for anything that appears to the contrary in the White Paper, it is in contemplation in certain circumstances to create a virtual monopoly in the production and supply of electrical energy over the entire area of the Free State in favour of a particular firm of contractors, the ultimate ramifications and reactions of which monopoly no man can foresee.

The Council urge that it would have been better in the first instance to have followed the usual procedure and to have appointed consulting engineers of repute to examine and report upon the power possibilities of the Shannon having regard to all interests involved.

In the event of the report of these engineers being in favour of a scheme of power development, the Government, if they thought fit, could instruct them forthwith to proceed with the preparation of the Parliamentary Plans, so that the measure might pass the Legislature in the ordinary course with the least possible delay. When the Parliamentary Sanction has been obtained, they should then prepare fully detailed contract plans and specifications for the scheme upon which world-wide competition should be invited.

In the event of the Government deciding not to proceed with the scheme of its consultants as a State enterprise, it will then be open to the Government to invite, by public notice, offers from outside organisations, including firms such as Siemens-Schuckertwerke, to finance and carry out the development work in accordance with the plans of the consultants and subject to such safeguards as the State may consider it necessary to impose.

The Council submit that only by such methods as these will the true interests of the State be served.

I am, Sir, your obedient servant,
D. G. GILLMAN, *Clerk to the Council.*

Ministry of Industry and Commerce, Dublin.
March 28, 1924.

Clerk to the Council,
Institution of Civil Engineers of Ireland,
35, Dawson-street, Dublin.

A CHARA,—I am directed to acknowledge the receipt of your letter of 24th instant on the subject of the proposed Hydro-Electric scheme on the Shannon, and to say that the department is obliged for your letter and fully appreciates the point of view from which the representations by your Council have been made. Your Council, however, may not have sufficiently considered the possibility that it is only by associating a firm of contractors with the project more directly than is customary that a practicable scheme on an economic basis can be devised on the Shannon for the whole Free State. Messrs. Siemens are the first and, so far, the only persons to assert that such a scheme is practicable, and the present occasion for the employment of experts arises solely out of Messrs. Siemens' proposals. It was considered to be plainly in the public interest that Messrs. Siemens should be afforded an opportunity to establish their claims. As, however, it is the judgment of independent experts and not the firm's claims that will determine the ultimate action to be taken, the safeguard of independent professional opinion which your Council postulates is amply secured. The procedure contemplated by the Government differs in its effects from that recommended by your Council only in so far as it will secure for consideration by the experts concrete and detailed proposals by a contracting firm of great experience and repute in place of a reference from a Government department necessarily vague and tentative in character and one which in the light of previous investigations there is no present reason, apart from Messrs. Siemens' offer, to put forward. The arrangement adopted provides a reliable and expeditious method of arriving at practical conclusions on a question of great economic importance, and when carefully examined does not seem to involve such dangers to the welfare of the State as your Council apprehends.

The other points of objection mentioned in your letter also appear to rest on some misconceptions as to the effect of the correspondence in the White Paper. While the arrangements made contemplate Messrs. Siemens as the contractors for the scheme if it is approved, the scheme will either be promoted by the Government as a State measure or by a statutory body which, though it may be organised by Messrs. Siemens, will in fact be a public undertaking to be established under and controlled by the laws of the Free State. In either case the consultants in effect will be the independent experts, and the scheme will not be adopted unless endorsed and approved by them, when it will be carried out in all details subject to their advice and only on such terms as the Oireachtas may approve.

A scheme for the provision of power from one source for the whole Free State obviously connotes for the time being a virtual monopoly, but monopoly within a defined area is for economic reasons an accepted principle of electrical supply under statutory powers, and there is no obvious reason why that principle should become inapplicable because the contemplated area is the whole Free State.

The department appreciates the anxiety of your Council lest a scheme originating with a contracting firm should be adopted without adequate safeguards for the public interest, but is of opinion that the essential conditions under which alone the contemplated scheme would be practicable, as well as the provisions in the correspondence published as a White Paper, supply such safeguards, and that your Council has perhaps not made sufficient allowance for the fact that under present conditions a decision as to the practicability of a national scheme on the River Shannon may depend at least as much on the responsibility taken for it by a particular contractor as on any other factor.

Mise, do chara,
(Signed) GORDON CAMPBELL.

The Institution of Civil Engineers of Ireland,
35, Dawson-street, Dublin. April 15, 1924.

To the Ministry of Industry and Commerce,
Government Buildings, Dublin.

SIR,—The Council of the Institution of Civil Engineers of Ireland beg to acknowledge the receipt of the letter of the 28th ult. of the Ministry of Industry and Commerce, and to state that the Council have, in addition, noted the replies given by the President to the questions put to him on this subject as reported in the Parliamentary debates on the 2nd inst.

After careful consideration of these the Council see no reason to depart from the views as expressed in their letter of the 24th ult. regarding the procedure proposed to be adopted by the Government in the matter of power development from the River Shannon. Briefly, these views are that the proposed procedure is unsound in so much that it eliminates competition whether in the matter of design, cost, or source of power supply, and, that the grant of a monopoly to a particular firm of contractors embracing the entire Free State area cannot fail to paralyse all native efforts in the development of the power resources of the country. The Council wish to make clear that they have approached this matter under a deep sense of responsibility to the country, feeling that they were best qualified to appreciate the dangers of the procedure proposed, and their letter of the 24th ult. was addressed to the Government solely in a spirit of friendly warning.

As, however, the Government have not thought fit to be guided by the views of the Council and have announced their intention of proceeding with the scheme as outlined in the White Paper of February 26, 1924, no useful purpose would seem to be served by a continuance of this correspondence. In the circumstances the Council deem it their duty to publish the correspondence so that their views may be upon record.

I am, Sir, your obedient servant,
(Signed) D. F. GILLMAN,
Clerk to the Council.

BUSINESS WITH CANADA.—Mr. F. W. Field, who has for some years held the post of Trade Commissioner at Toronto, and who has recently been appointed to the post of Senior Trade Commissioner in Canada, is at present on his way to this country for the purpose of an official visit. Mr. Field will be in attendance at the Department of Overseas Trade from May 12 to 31, where he will be pleased to interview British manufacturers and merchants interested in export trade with Canada. Subsequently visits will be paid to the principal industrial centres of the United Kingdom. Applications for interviews in London should be made at once to the Controller-General, Department of Overseas Trade, 35, Old Queen-street, S.W.1, the reference T.G. 5282 being quoted in all cases.

ORIENT LINE'S ENTERPRISE.—The Orient Steam Navigation Company, who are building two new large and powerful vessels for the Orient Line Mail Service to Australia, have decided to build at once a third ship, the order for which has been given to Messrs. Vickers for delivery within 18 months. All these vessels will be of 20,000 tons register, 20,000 h.p. and oil-driven. They will be 658 ft. long, with a beam of 75 ft., and will be planned to carry two classes of passengers only, about 600 first class and about 1,200 third class. The first of these steamers, the Orama, is to be launched at Messrs. Vickers' Yard on May 20. The second, the Oronsay, is making rapid progress at Messrs. John Brown and Co.'s Yard, Clydebank, and will be launched early in the autumn. These three new steamers, and the company's Ormonde, 15,000 tons, will provide the regular monthly sailings to and from Australia of the Orient Line Fast Mail Service.

NOTES ON NEW BOOKS.

IF we understand by fuel oils simply oils to be burnt under boilers, as distinct from fuel for internal-combustion engines, the technology of fuel oils may be said to be fairly well established and to have undergone little development in the last few years. Mr. H. V. Mitchell, late chief Chemist to the British Burma Petroleum Company and also assistant to the late Sir Boverton Redwood, takes the term essentially in this restricted sense in his volume on "*Fuel Oils and their Applications*" (London: Sir Isaac Pitman and Sons, Limited; price 5*s.* net), though the first general half of the book naturally deals with features of equal importance to oil fuels intended to serve as direct-power producers by their combustion. As an introductory treatise on the sources, classification, and production of fuel oils and the principles and apparatus involved in their selection, examination and use, Mr. Mitchell's book of 171 pages, including the index, which might be longer, is quite useful. With page 70 we come to atomisers, furnace arrangements, typical burners, oil-fired locomotives, and short sections on oil fuel at sea and for manufacturing purposes—matters which are expanding without noteworthy novel development. It is hence not surprising that references, not plentiful in any case, to later dates than 1920 are scarce; the reference to Mr. B. L. W. Bates' researches on colloidal fuel goes back to that year, and we are not aware of any subsequent publication on this work.

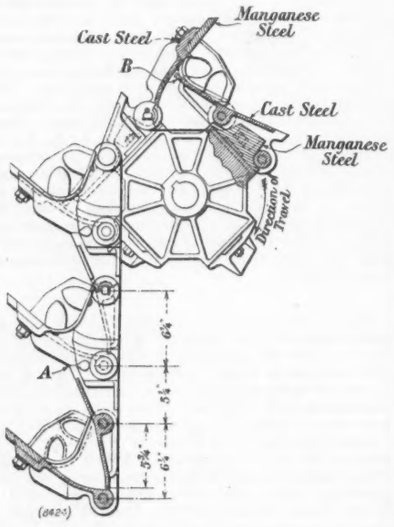
Circumstances may necessitate the publication of technical books in instalments, but the plan is not generally advantageous. Apart from other objections, there is the increased risk of an author finding himself unable to complete, or to take up again, in a new edition, work upon which he started years ago. That fate has befallen a new section of the "*Handbuch der Ingenieurwissenschaften*" and of its fifth part, "*Eisenbahnbau.*" The new section in question, by Dr. Ing. H. Heumann of Aachen, on "*Drehscheiben*" (turntables; Leipzig: Wilhelm Engelmann, price 8*s.*), had originally been written by R. Anger, who began to deal with the subject in the second edition, but had to leave the completion, delayed by adverse times, to Dr. Heumann. Almost all the 138 illustrations of the volume of 160 pages are taken from installations due to German or Austrian firms.

The syllabus of any examination is but a very imperfect guide to the character of the knowledge demanded and the standard of attainment required. Old examination papers, when available, form a very useful, and to the private student, almost indispensable supplement to the syllabus. Many sea-going engineers have to rely largely on private study, and to these, "*Latest Questions in Engineering Knowledge*," compiled by Mr. W. C. Macgibbon, M.I.Mech.E., Principal of the Glasgow School of Marine Engineering, will be of particular value. The work, which is published by Messrs. James Munro and Co., Limited, Glasgow, at 10*s.* net, contains not merely an excellent and varied selection of typical questions, but to each a detailed answer is appended. The illustrations are numerous and well chosen, many being reproduced from working drawings. Practically the whole field of marine engineering is covered, including not merely ordinary engine and boiler room equipment, but refrigerating plant and deck machinery. Considerable space is devoted to the Diesel engine and to oil fuel, both of which are steadily coming more and more into vogue at sea.

The solution of formulas and equations is facilitated by the use of numeric tables and diagrams by the aid of which the values of function may be found for definite values of the variables. The branch of mathematics which deals with these problems is known as nomography. The term was introduced, at the end of the last century, and it has since become customary to comprise under the name of nomograms both numerical tables and diagrams designed for this purpose. Most of the early treatises on the subject, like those of Mehmke and of d'Ocagne, were too mathematical for the practical man. Nomography is now a college subject for advanced students, however, and Professor P. Werkmeister, Dr. Ing. of the Technical High School at Stuttgart, has compiled his volume on "*Das Entwerfen von Graphischen Rechentafeln (Nomographie)*" (Berlin: Julius Springer; price 2·40 dols.) with the object of making the use of nomograms more popular and easy. He refrains, therefore, so far as possible from theoretical deductions and from the use of determinant notation and gives numerous examples. He seems to have succeeded in explaining this difficult subject by the 194 pages and 164 diagrams of his volume, dealing in his last section with equations of more than three variables.

THE BARBER-GREENE TRENCH DIGGER.

SINCE we described in our issue of September 28, 1923 (page 397), the original model of the vertical boom trench digger constructed by the Barber-Greene Company of Aurora, Ill., U.S.A., the makers have introduced certain detail improvements in the machine, some of which were briefly noticed in our issue of November 9, 1923 (page 593). We have now received particulars of an altogether new model which, while retaining the essential features of the original design, embodies modifications which make the machine much more speedy in working and more easily controlled, while adding greatly to its strength. In this new design the caterpillar tracks are increased in length and a spring-controlled idler takes up the slack of the track chains. The power unit is now a 4-cyl. 38-h.p. petrol engine, and is placed on a cantilever frame at the back of the machine, which position provides a better balance for the digging boom. This arrangement also simplifies the drive. The drive is furnished with the overload release sprocket described in our issue of November 9, 1923, page 593, thus protecting the digging gear from damage. The controls are all grouped and within reach of the operator's seat, the engine gear box being provided with a single master-gear shift lever. The boom hoist has been rearranged, and the cable is now wound on to a worm-driven drum which locks automatically in any position. This is

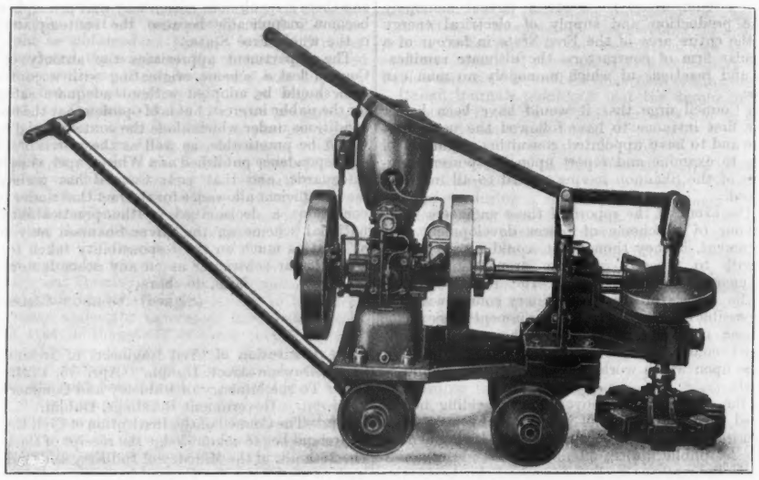


controlled by a friction clutch. The master clutch is operated by treadle, and is of the multiple dry-disc type, the other clutches being of the outside band type. All dangerous moving parts are enclosed.

The digging feeds are four in number, viz., 12 in, 18 in., 24 in. and 36 in. per minute, the changes being by lever. Three travelling speeds are arranged, namely, 45 ft., 91 ft., and 183 ft. per minute. A reverse speed of 48 ft. per minute is also available. The chain tracks are 63 in. long by 10 in. wide. The caterpillar frames are one-piece steel castings. Independent friction clutches are furnished for the chain tracks. The digging bucket chain has been made much more robust than formerly, the parts also having been redesigned for easier renewal. The new-type of chain is illustrated in the accompanying figure. The buckets form integral parts of the chain, and, as before, are self cleaning, a tail B on the back piece scooping out the contents of the following bucket as the two move round the top tumbler. The tumbler or driving sprocket is now furnished with renewable manganese steel driving blocks. The main parts of the buckets are of cast steel, but renewable manganese steel toothed digging lips are fitted. In addition, an improvement has been introduced which gives extra support and rigidity to the buckets while digging, each bucket being supported as shown at A by the one immediately below. The buckets are also furnished with sides, and have been made deeper. As an example of the work of which the new machine is capable we may state that in one case a length of 164 ft. was trenched to a depth of 5 ft. and a width of 18 in. in three hours, in spite of very adverse weather conditions. The representatives of the Barber-Greene Company in this country are the Allied Machinery Company, Limited, 70, Victoria Street, S.W.1.

TERRAZZO-FLOOR POLISHING MACHINE.

CONSTRUCTED BY MESSRS. W. CROCKATT AND SONS, LIMITED, ENGINEERS, GLASGOW.



TERRAZZO-FLOOR POLISHING MACHINE.

THE annexed illustration is reproduced from a photograph of a new model of polishing machine for inlaid marble and terrazzo floors, made by Messrs. W. Crockatt and Sons, Limited, at their works, 64, Darnley-street, Glasgow. The features of the machine will be readily grasped from our illustration. The main bedplate is of cast-iron and is mounted on four broad rimmed wheels, two of which are arranged in a swivelling carriage. The bed carries a two-stroke hopper-cooled engine which will run on either petrol or paraffin, driving direct a horizontal shaft which terminates in a "Fabroil" bevel pinion. This meshes with a larger bevel on a vertical shaft driven by the bevel by sliding feather and keyway. The horizontal shaft is carried in Hoffman ball bearings, while the vertical shaft is carried in a long sleeve mounted in ball bearings of the same make. The thrust of the large bevel is also taken on a ball race. At the lower end the vertical shaft is fitted with a large polishing head, the connection between the two being by universal joint so that the head can adjust itself to unevennesses in the floor. The head is arranged to take carborundum blocks which are adjustable individually. At its upper end the vertical shaft is coupled by means of short links to a lever pivoted on a pillar and continued towards the back of the machine so as to be within reach of the operator when at the carriage handle.

Hopper cooling which enables the machine to be run for an hour or two before the water requires changing, avoids the necessity of providing a large quantity of circulating water and keeps the weight moderate and the dimensions compact. The latter is an important feature in view of the fact that the machines have to be shipped from one job to another. The compactness of the machine is also an advantage when working in confined spaces. The wheel treads are broad so as to avoid damage to the flooring. The petrol consumption is at the rate of about 1½ pints per hour when the machine is fully loaded, but works out at much less on the average of a day's working. The rate of working is naturally dependant upon the nature of the surface to be treated; in some recent instances about 50 sq. yards have been finished from the rough in a day. This, of course, is much faster than the usual mode of hand polishing, besides giving a very much flatter surface as a result of the use of the large circular head. Messrs. W. Crockatt and Sons inform us that, having shipped one of these machines to the Far East recently, they promptly received an order for two others to surface about 150,000 sq. yards of floor, and in view of the number of large buildings being erected at the present time in this country, it would seem likely that there must be plenty of work here also for such an appliance.

NEW HEAT-TREATING TERM.—A new term, "lonealing," appears in the definitions of terms relating to heat-treatment operations tentatively approved by the Recommended Practice Committee of the American Society for Steel Treating, says *Canadian Machinery*. "Lonealing" stands for heating below the critical temperature, followed by any rate of cooling.

INSTITUTE OF METALS AND THE BRITISH EMPIRE EXHIBITION.

THIS institute has prepared a small booklet for the use of visitors to the British Empire Exhibition. This booklet, when bearing the visitor's signature, serves as a card of introduction to the meetings of the institute and to the library of the institute during the period of the exhibition. This facility is intended to appeal primarily to overseas visitors, who can obtain copies of the booklet either through their respective High Commissioners' offices in London; from the Secretary of the Institute of Metals, Mr. G. Shaw Scott, M.Sc., 36, Victoria-street, S.W. 1; or at the Exhibition, on Stand No. 237, Palace of Engineering. The distribution of the booklet is not, however, restricted to overseas visitors, and copies can be obtained by anyone interested upon application in writing to Mr. Shaw Scott at the above address.

On Stand No. 237 at the exhibition—that of the Non-Ferrous Metal Trades Joint Committee—the Institute of Metals has a unique display illustrative of the corrosion of condenser tubes. The exhibit includes coloured diagrams showing sections of tubes and the scales which are formed upon them in sea water. The diagrams show that the rate of corrosion of the tubes is mainly dependent upon the properties of the scale. A set of diagrams gives the reactions as a result of which scales are formed. The ways in which the scales may break down locally, and so give rise to pitting, are also illustrated. Actual tubes taken from commercial condensers illustrate each type of corrosive action. A novel method is shown for protecting aluminium from the action of sea-water, especially under conditions in which the aluminium is liable to be alternately wetted and dried. There is further displayed a remarkable series of specimens of aluminium protected by this method. A means has been found whereby aluminium can be rendered not only resistant to corrosion, but also coloured, thus making the metal particularly suited for decorative purposes. The possibilities in store for the new process should be large. Thus, coloured aluminium in thin sheets used in place of wall-paper would last for years, and could be washed down to an unlimited extent; similarly, coloured aluminium panelling could be used in the construction of motor-car bodies, replacing paint-work.

NEW INDUSTRIAL DISTRICT ON THE THAMES.—The Thames Land Company, Limited, 47, Parliament-street, Westminster, S.W. 1, has issued particulars of the industrial district at West Thurrock, Essex. The company was formed in 1916 to acquire undeveloped properties at West Thurrock, with a view to establishing a large industrial estate near London, on the Thames. It now owns about 3,000 acres of land having 2 miles of deep water frontage. The London and Tilbury Branch of the London Midland and Scottish Railway passes through the estate; the estate is also intersected by three main roads to London, and is already provided with gas, water and electricity. The company owns the freehold of the estate and proposes to sell or lease the land in large or small sites. Further data can be obtained from Mr. W. Ogden Taylor, of the Company's Commercial Department.

HYDRAULIC FIRE LADDER FOR RANGOON.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, LIMITED, ENGINEERS, GREENWICH.

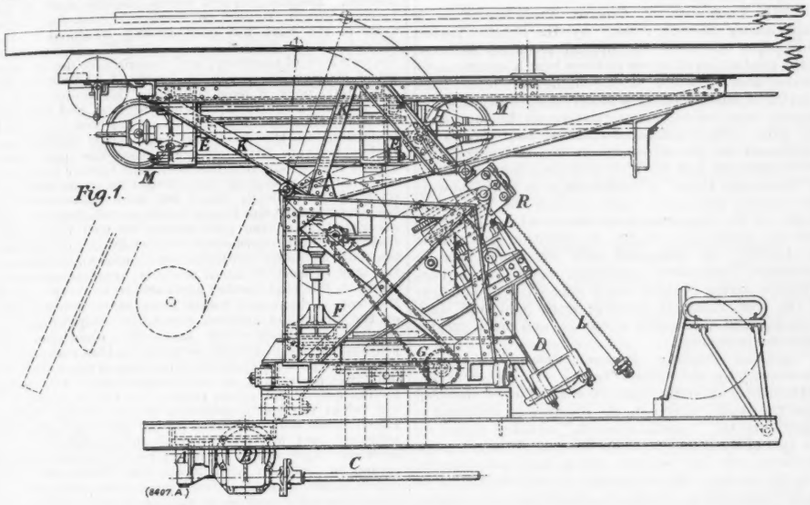


Fig. 1.

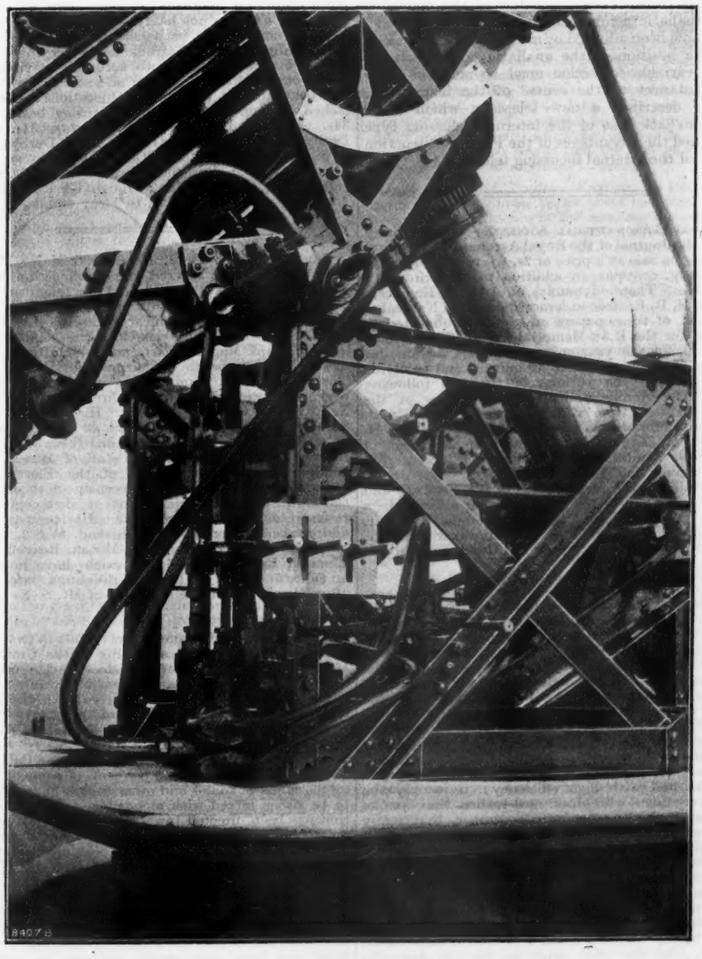


FIG. 2. SIDE VIEW SHOWING GEAR AND INDICATOR DIALS.

THE INSTITUTE OF TRANSPORT.—The fourth congress of this Institute will be held at Bristol from May 29 to 31. The proceedings will comprise the reading and discussion of papers on the mornings of the two first days. The programme includes visits to docks, canals and works. Further particulars of the arrangements can be obtained from the Secretary of the Institute, 15, Savoy-street, Victoria Embankment, W.C. 2.

HYDRAULIC FIRE LADDER.

WE illustrate in Figs. 1 to 4 on the present page and on page 578, an automobile aerial ladder for fire-brigade use, in which the ladder-operating mechanism is worked by hydraulic power throughout. The machine, the first on this principle, has been constructed by Messrs. Merryweather and Sons, Limited, Greenwich, under the patent of Mr. G. Lee Tuppen, chief officer of the Rangoon Municipality Fire-Department, to whom it was recently delivered. This automobile aerial ladder is an entirely different model from the one we described and illustrated on page 200 of our issue of February 16, 1923, also built by Messrs. Merryweather, and in which, as will be remembered, the whole of the ladder raising, lowering and adjusting mechanism was operated by specially designed gearing driven by the engine which propels the automobile.

In the Rangoon automobile aerial ladder the pressure oil supply is furnished by a three-throw pump shown at A in the drawing, Fig. 1. It is fixed at the rear of the chassis and driven by a worm reduction gear B from an extension of the engine shaft C, through the change-speed gear-box. The pump delivers oil at a working pressure of about 450 lb. per sq. in., the relief-valve operating at 600 lb. The oil is distributed by control levers to three different pieces of apparatus, namely, a ram for raising the ladder lengths D, a ram for extending them E, and a motor F, for revolving the turn-table on which they are pivoted. The raising ram D is fixed on the centre line of the turntable G, and carries a yoke piece H which is fixed to each side of the pivoted framework K, to which the ladder lengths are attached. This framework also carries two hinged toothed rods L placed side by side and engaging with ratchet teeth R, which act as a safety device, should the hydraulic power fail for any reason. The extending ram E is fitted as close up to the ladder as possible; it carries a six-wire pulley system M in duplicate, so that its length of stroke is multiplied six times and gives the full travel of the first sliding ladder length. The motor F for revolving the turntable on which the ladder is pivoted is of a rotary type having six pistons fitted with rollers, the control gear being so arranged that the motor will start in any position. All three movements, the raising of the ladder, its extension and the revolving of the turntable, can also be carried out by hand gear in case of emergency. The mechanism is shown in the outline diagram, Fig. 1, and in the views, Figs. 2 and 3. The view, Fig. 4, shows the ladder lowered and folded down ready for the road.

The ladder is in four lengths, capable of extension to 93 ft. It is of the Merryweathers' standard design, the lengths having trussing members on their upper sides in accordance with the makers' standard practice.

The chassis on which the ladder is mounted is of the standard Merryweather fire-service type, having a four-cylinder, 65 b.h.p. motor, with chain-drive to the rear wheels. Four hinged struts attached to stretchers secured to the chassis framing are provided, each having jacking screws for taking the load off the springs and tyres, thus forming an extremely rigid foundation for operating the ladder when it is extended at a low angle, or at right angles to the chassis. The struts are seen in the view Fig. 4. A complete system of indicator plates is in sight of the operator, showing the exact extension of the ladder and the safe angle at which it can be used for any given extension.

A demonstration of the working of the machine was recently given in the grounds of the Royal Naval College, Greenwich, by permission of the Admiral Superintendent, during which the mechanism worked swiftly, noiselessly and without the least hitch.

THE NEW FRENCH LIGHT CRUISERS.—The preliminary investigations for the designs of the new French cruisers of the 10,000-ton type are not yet completed. It has, none the less, been decided that these vessels shall carry eight 7·9 in. guns, mounted in four centre line turrets, and sixteen 2·9 in. anti-aircraft guns. Great attention is being paid to the question of defence against aerial attack, and each cruiser is to carry two aeroplanes which are to be launched by catapults. The I.H.P. is to be between 120,000 and 130,000, and they are to have a maximum speed of 34 knots.

DIESEL ENGINE USERS' ASSOCIATION.—At the next meeting of the Diesel Engine Users' Association, which is to be held on Friday, May 9, at the Engineers' Club, Coventry Street, W.1, a Paper by Messrs. A. H. Dykes and W. T. Townend on "Electricity Supply in War Time as Affected by the Improvements in Heavy-Oil Engines," is to be read and discussed. The paper deals with the present-day tendency to replace the existing smaller electricity supply stations by capital stations and to the liability of such stations to aerial attack in the event of war. Non-members interested in the subject and desirous of attending the meeting can make application for tickets of admission to Mr. Percy Still, Joint Honorary Secretary of the Association, 19, Cadogan Gardens, London, S.W.3.

THE ATLANTIC TRANSPORT LINER "MINNETONKA."

THE latest example of ship construction by Messrs. Harland and Wolff Limited, of Belfast, the steamship Minnetonka, built for the Atlantic Transport Company Limited, will make her maiden trip on the direct route between London and New York on Saturday, May 3. The dimensions of the vessel are: length, 625 ft.; breadth, 80 ft.; and depth, 53 ft. 6 in. With her 21,998 tons, gross register, the Minnetonka will prove to be the largest liner turned out by a British builder during 1924. The new ship has a straight stem and cruiser stern. Double bottoms extend right fore and aft, and subdivision is provided by fourteen watertight bulkheads extending to the shelter deck. In addition to accommodation for 369 first-class passengers on the lower promenade, shelter and upper decks, the Minnetonka has a cargo capacity of about 20,000 tons.

The propelling machinery of the vessel consists of Brown-Curtis turbines, driving through single reduction gearing. An astern turbine is incorporated within the exhaust casing of each low-pressure turbine. Steam is generated in 12 water-tube boilers, which are arranged for oil burning, working under assisted natural draught, and providing steam at a working pressure of 215 lb. per square inch, with 100 deg. F. superheat.

In the passenger accommodation the characteristics are quiet dignity and cosy homeliness. All entrances are lined from floor to ceiling with oak panelling, and open into a reception room in which fluted pilasters appear between the panels of the walls and a carved frieze runs round the room. The sober note is broken by the figured silk upholstery of the comfortable cane furniture. In this room an organ and a grand piano are provided for entertainment, and the floor, of oak parquetry, has been specially arranged for dancing. Opening out of the reception room there is a spacious dining room extending over the whole breadth of the ship. Like the other public rooms, this has a height of 10 ft. Accommodation is provided for 322 diners. The walls are plainly panelled in the Georgian style and are entirely white, while the furniture is made of oak. The lounge on the upper deck is panelled in a style which was popular in England in the middle of the seventeenth century, though sycamore, a wood rarely used then, is employed. Glazed cane easy chairs and settees are provided here for the comfort of the passengers. In the reading and drawing-room, decorated in the way favoured by the Brothers Adam at the close of the eighteenth century, there are ivory white walls with small engravings embodied in the panelling and separated by ornamental pilasters. The air of elegance is preserved in the design of the fireplace, the curtained windows, and the gay coverings of chairs and sofas. In the smoking room there is much more solidity, but great comfort. The walls are of cedar and the furniture of walnut, with dull blue leather coverings. Settles are built into the walls, and are reminiscent of the days of Johnson and Goldsmith. The cabin accommodation leaves nothing to be desired, and provision is made of electric heaters and fans, independently controlled, in addition to the main ventilation. Now that the Atlantic Transport Company Limited, which lost so many vessels during the War, has two large passenger ships, the Minnewaska and the Minnetonka, on the direct run from London to New York, a fortnightly service from each end will be maintained.

FRENCH "HORSE-POWER" DESIGNATION.—A committee of the Société des Ingénieurs Civils de France has decided against the use of the two letters C.V. (*cheval-vapeur*) in place of H.P., and has recommended the abbreviations ch. for horse-power and ch. h. for "cheval-heure," horse-power hour. These latter abbreviations are those which are now to be used throughout France.

A METHOD OF SMOKE CONSUMPTION.—To obviate trouble with the local authorities from the production of smoke at the Almagam Mills of the Associated Rubber Manufacturers, Limited, Harpenden, smoke-consuming apparatus has recently been installed at the mills by "Eureka" Smoke Consumers, Limited, 163A, Strand, W.C.2, and is now in operation. The steam-generating plant comprises a Cornish and a Lancashire boiler, the grate area of the former being 18 sq. ft. and that of the latter 25 sq. ft. Small coal is burnt in the Cornish boiler, and the products of combustion from this boiler are drawn by a suction fan and delivered, together with some additional air, into the closed ash-pits of the Lancashire boiler. The latter is fired with coke, and the smoke from the first boiler, in passing through the coke fire, is completely consumed, the products of combustion of both boilers leaving the stack in a practically invisible form. At a demonstration of the system, given on Wednesday last, the smoke-consuming apparatus was disconnected, allowing the production of dense smoke, which was reduced to a negligible quantity when the apparatus was again put into action. The system has been patented by Mr. W. T. Cashman, J.P.

THE OPTICAL SOCIETY.

AT a meeting of the Optical Society held at the Imperial College of Science and Technology on Thursday, April 10, 1924, the following papers were presented and discussed.

"*The Feasibility of Cinema Projection from a Continuously Moving Film*," by H. Dennis Taylor. This paper discussed the optical problems involved in the production of screen pictures from a continuously moving film. The film picture might be reflected from a series of mirrors suitably mounted on a drum which rotated at a definite speed relative to the motion of the film. The various oscillations that might be introduced on the screen image by such projection were discussed, and methods described for minimising or eliminating them. Calculations were made showing the relation that must exist between the back focal length of the projector lens, the number of mirrors and the position of stops, if definition was to be satisfactory. As compared with the usual type of projection, continuous projection results in a considerable saving of light, much reduced wear and tear of the film, complete freedom from light and dark flickering and consequent eyestrain, and much greater quietness in running.

"*A New Perfectly Anallatic Internal Focussing Telescope*," by E. Wilfred Taylor. In all surveying instruments, where the distance of an object is deduced from the stadia intercept, the distance so obtained is referred to the "anallatic point," situated either on the axis of the telescope or on the axis of the telescope produced. If the anallatic point does not coincide with the centre of the instrument, a correction must be applied in order to obtain the distance of the object from the centre of the instrument. The introduction of the anallatic lens by Porro automatically referred all distances, deduced from the stadia intercept, to the centre of the instrument, since the latter coincided with the anallatic point. The internal focussing telescope has now been adopted by most instrument makers and, as the position of the anallatic point varies, a small but variable correction must be made in order to refer distances to the centre of the instrument. The paper described a new telescope which while perfectly anallatic was of the internal focussing type and combined the advantages of the Porro construction with those of the internal focussing telescope.

THE ROYAL AERONAUTICAL SOCIETY.—The February number of the Journal of the Royal Aeronautical Society, which is now on sale at a price of 2*s.* 6*d.* to non-members of the Society, contains, in addition to a reprint of a paper on the "Thermodynamics of Aircraft Engines," read by Mr. H. R. Ricardo at a meeting held in November last, the first of three papers on airships submitted in competition for the R.38 Memorial Prize. The Council have decided, for this year only, to increase the amount of the prize from 25 guineas to 40 guineas and to divide this sum between the authors of the two following papers:—"The Aerodynamical Characteristics of the Airship as deduced from Experiments on Models, with Application to Motion in a Horizontal Plane," by Mr. R. Jones, and "A Detailed Consideration of the Effect of Meteorological Conditions on Airships," by Lieut.-Col. V. C. Richmond and Major G. H. Scott. Mr. Jones' paper is printed in the current issue of the JOURNAL and the second paper will be published later, as also will be a paper on "The Strength of Rigid Airships," by Mr. C. P. Burgess, Commander J. C. Hunsaker and Mr. S. Truscott, which paper the Council desire specially to commend.

LOW-TEMPERATURE COKE.—Much has been said in favour of low-temperature coke as a solution of the smoke problem, and if all small consumers would adopt this fuel such claims would probably hold good, say the United States Bureau of Mines, Department of the Interior, and the Carnegie Institute of Technology, in Bulletin 8, on Coal Mining Investigations. In the interest of smoke abatement it is not necessary for large consumers to use coke, excepting perhaps the railroads, and further, it may be questioned on good grounds whether this course will ever be economically feasible. Large power-plants can and do burn bituminous coal with little smoke and with high efficiency; it is only the small power user—who does not realise that smoke means waste—also the domestic consumer, that really require a smokeless fuel. Here indeed would seem to lie the legitimate field for low-temperature coke; but it must have something to recommend it besides its smokeless qualities in order that it may be made to bear a reasonable part of the process costs. It must command a higher price than competing fuels, and to this end it must be more economical, or more convenient to use, or both. So far this has not been demonstrated industrially; on the other hand, no one can deny the possibility of such success in the future. Laboratory experiments can only give indication of carbonisation conditions which will produce a suitable fuel; the economic phases of the question must be answered through demand on the part of the consumers. Obviously, a lasting demand cannot be created or maintained through unsupported statements appearing in the technical literature.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The details of the distribution of the new cruiser orders have created considerable disappointment among armament firms operating in the Sheffield district. Despite frequent representations made to the Government in respect to Sheffield's post-war plight, none of the work has been directly allocated to this district. To a limited extent Sheffield may share in the provision of machinery and materials for use by those naval contractors who have benefited. Otherwise the city's only hope of assistance from this source rests in the placing of contracts for guns, armour, and auxiliary parts, the allocation of which has not yet been announced. Conditions in the steel and engineering trades have undergone very little change during the past week, except that production has been still further increased, and that the receipt of more wages demands has complicated the outlook. Over 500 more operatives have been set on since the Easter holidays, bringing the total absorbed during the past month to well over 2,000. Owing to the exceptionally keen character of competition both at home and from Continental manufacturers, the bulk of work in hand, however, is unremunerative, and it is felt that further additions to working costs in the way of increased wages must react detrimentally on the amount of business secured in competition with tax-free or State-aided industries elsewhere. The principal source of trouble seems to be that comparisons with wages paid in the building trades and other sheltered industries are setting up a widespread spirit of dissatisfaction among operatives engaged in trades whose selling prices are solely governed by competitive factors. Locomotives sent to France during the war have been returned, and are under repair to supplement home services. Agricultural engineers report a more hopeful feeling in business with Spain and Portugal. More orders, again on a strictly cash basis, have been accepted from Russia for supplies of saws, and farm implements.

South Yorkshire Coal Trade.—With the advent of warmer weather the demand for house coal has eased considerably, and contractors are bringing deliveries more up-to-date. Prices, however, show no weakening tendency, and are not likely to decline while transport facilities continue to be deficient. Industrial fuels are uniformally strong, contract deliveries to home and export buyers continuing to account for virtually the whole output. Cobbles, nuts and slacks are all scarce, and coke difficult to obtain. Quotations:—Best hand-picked branch, 36*s.* to 39*s.*; Barnsley best Silkstone, 34*s.* to 36*s.*; Derbyshire best brights, 31*s.* to 35*s.*; Derbyshire best house, 27*s.* to 29*s.*; Derbyshire best large nuts, 27*s.* to 28*s.*; Derbyshire best small nuts, 20*s.* 6*s.* to 23*s.*; Yorkshire hards, 27*s.* to 30*s.*; Derbyshire hards, 25*s.* to 28*s.*; rough slacks, 12*s.* 6*d.* to 15*s.* 6*d.*; nutty slacks, 12*s.* to 14*s.*; smalls, 8*s.* to 10*s.*

PERSONAL.—Mr. H. J. Deane and Major F. M. Du Plat Taylor have severed their connection with the Port of London Authority and have taken an office at 36, Victoria-street, Westminster. They will practise as consulting civil and mechanical engineers.—Lieut.-Colonel H. K. Stephenson, who was closely associated with the late Sir Frank Mappin, Bart., and who, after the latter's death in 1920 became chairman of Messrs. Thomas Turton and Sons, Limited, has now in addition taken over the duties of managing director in place of Mr. S. J. Young, who has resigned. His son, Mr. W. R. S. Stephenson, will continue to act as assistant managing director.—Mr. C. F. Mackness, M.I.E.E., who has been for the last ten years on the staff of Messrs. Vickers, Limited, London, in charge of the Electrical Sales Department, and was until recently chief engineer of the Hydro-Electric Department of that company, has resigned as from February 29. His present business address is 37, Norfolk-street, Strand, W.C.2, and Telephone number, Central 1091.—Messrs. Reavell and Co., Limited, Ranelagh Works, Ipswich, have now opened an Office at 49 and 50, Imperial Buildings, Oxford-street, Manchester. It will be in charge of Mr. S. N. Howe.

ZIRCONIUM.—Zirconium occurs mainly in two minerals, baddeleyite and zircon, according to the United States Department of the Interior. Most of the baddeleyite ore is found at Sao Paulo, Brazil. It is sold in the United States in a natural mixture with zircon, under the trade name of zirkite, and contains about 75 per cent. zirconium dioxide. Many placer deposits derived from the disintegration of granitic rocks carry zircon. A deposit of zircon sand has been located at Pablo Beach, Florida, and as much as 3 per cent. of some of the auriferous sands of Idaho and other States have been found to be zircon mixed with monazite. Considerable attention has been directed toward zirconium in recent years on account of its giving unusual properties to ferro-alloys. Zirconium oxide (zirconia) has been investigated as a refractory because the melting-point of this compound is about as high as that of any other known oxide. Zirconium salts also have some importance; they have been used for dressing silk, as mordants in dyeing, and for many other purposes. With the new investigations of zirconium and its increased commercial uses there have also been attempts to improve the methods of determining this element, but at the present time there is much to be desired in the speed and accuracy of these processes. Methods for the determination of zirconium, which have been tested by the Bureau of Mines, are given in Bulletin 212, "Analytical Methods for Certain Metals," which is obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C., at a price of 40 cents.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Whilst sales of Cleveland pig-iron are not heavy, a fairly good export business is absorbing current make, and as stocks are practically all sold, the position may be described as distinctly encouraging. Home trade is quiet, but improvement is looked for. The continued comparative cheapness of Cleveland pig is attracting custom from markets abroad which for some time past have been lost to this district. Scotland is taking rather more iron from Tees-side. No. 1 Cleveland pig is very scarce and is quoted 95*s.* to 97*s.* 6*d.*; No. 3 g.m.b. is 91*s.* 6*d.* to 92*s.* 6*d.*; No. 4 foundry, 91*s.* to 91*s.* 6*d.*, and No. 4 forge, 91*s.*—all f.o.t. makers' works and f.o.b. Tees.

Hematite.—Encouraging accounts are given of East Coast hematite. In this branch also demand is mainly on continental account, but a fair amount of home buying is reported, and the statistical situation is strengthening, though there are still rather considerable stocks to liquidate. Sheffield has bought a little iron from this district. Nos. 1, 2, and 3 are fully 99*s.* f.o.b. Tees, but for inland delivery rather more is asked. No. 1 hematite is put at 100*s.*

Foreign Ore.—There is continued absolute stagnation in foreign ore, consumers having good supplies and being altogether off the market, so that recognised quotations on the basis of best rubio at 24*s.* c.i.f. Tees are purely nominal.

Blast-furnace Coke.—A distinctly easier feeling in Durham blast-furnace coke is noticeable. Sellers name round about 30*s.* for good average qualities delivered to local consumers, but customers claim they can satisfy needs at a lower figure.

Manufactured Iron and Steel.—Rather better inquiry for one or two descriptions of finished iron and steel is reported, but new business is not easily arranged. Quotations show little or no movement. Common iron bars are 12*l.* 10*s.*; iron rivets, 14*l.*; packing (parallel), 9*l.*; packing (tapered), 12*l.*; steel billets (soft), 9*l.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 13*l.* 10*s.*; steel ship, bridge, and tank plates, 10*l.* 5*s.*; steel angles, 10*l.*; steel joists, 10*l.*; heavy sections of steel rails, 9*l.*; fish plates, 13*l.*; and galvanised corrugated sheets, 17*l.* 10*s.*

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—With general trade conditions still somewhat unsettled buyers of steel material continue reluctant to enter into commitments of any note, with the result that the steel industry is really only marking time at present. A more settled atmosphere in the labour market is the first thing which will have any effect on the trade, as shipbuilders have quite a fair number of orders booked, and with the placing of a cruiser at Fairfield the outlook is much better. Meantime plate mills are not running anything like full, and while sectional material is in quite good demand there is nevertheless much room for improvement. Black sheets are moving freely overall, but some weeks there is less business passing. The foreign demand is keeping up wonderfully well. Prices show no change and are as follow: Boiler plates, 13*l.* 10*s.* per ton; ship plates, 10*l.* 5*s.* per ton; sections, 10*l.* per ton; and sheets, 12*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—No improvement falls to be recorded in the West of Scotland malleable iron trade. Makers are finding great difficulty in securing specifications of sufficient tonnage to keep plant running, and as inquiries are not very plentiful the outlook would seem to be growing worse week by week. New business is almost entirely absent. Prices are unaltered with "Crown" bars called 12*l.* 10*s.* per ton, delivered Glasgow stations. The re-rolled steel branches have improved a little over the week.

Scottish Pig-Iron Trade.—There has been little change in the state of the Scottish pig-iron trade over the week, and while there may be a trifle more life in the industry it is really of little moment. Foreign buyers continue to send along orders, but the bulk is far from satisfactory and is easily overtaken. Home consumers are also ordering with caution, and stocks on hand are equal to all demands. Prices are nominally unchanged, and are as follow: Hematite, 5*l.* 2*s.* 6*d.* per ton, delivered at the steel works; foundry iron No. 1, 5*l.* 5*s.* per ton, and No. 3, 5*l.* per ton, both on trucks at makers' yards.

Scottish Pig-Iron Shipments.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, April 26, amounted to 1,059 tons. Of the total, 956 tons went overseas and 103 tons coastwise. For the corresponding week of last year the figures were 3,780 tons overseas and 92 tons coastwise, making a total shipment of 3,872 tons.

Shipbuilding.—There is no doubting the fact that Scottish shipbuilding presents a more hopeful front than it did up till recently, and the prospect of a steady run for some time is almost assured. Not only have bookings improved, but labour troubles are not so menacing as they were. With regard to new tonnage, there were at least half a dozen vessels placed during the past month, and also—within the past week—an order by the Admiralty for one cruiser to be built by the Fairfield Shipbuilding and Engineering Company, Limited, Govan, Glasgow. The builders will supply the machinery. Messrs. William Beardmore and Co., Dalmuir, have also been successful, and have been commissioned to supply the propelling machinery for one of the three cruisers to be built at the Government dockyards. The output of new tonnage last month was very satisfactory, and was quite a good average. The figures for the different districts are as follow:—

	Vessels.	Tons.
The Clyde	21	34,114
The Forth	3	4,140
The Tay	1	2,000
The Dee and Moray Firth ...	2	2,190
Total	27	42,444

The Clyde figures are down from the previous month, when 58,218 tons were launched, but when the total of 139,856 tons for the four months of the year is compared with other recent years it shows an improvement which is for the good, although it is a long way behind the output of 237,161 tons for the first four months of the record year 1913.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—There has been a further slackening off in the demand for coal. Prices have been reduced, but even at the lower values sellers in a number of cases experienced difficulty in securing sufficient business to keep pits working regularly. The reduction in prices has, however, brought in a number of inquiries for forward business, but with the wages question still unsettled colliery salesmen were not inclined to operate forward at current values. Best Admiralty large was offered at 28*s.*, while seconds were round 26*s.* 6*d.*, with the dry descriptions from 25*s.* to 27*s.* Smalls, too, were in ample supply, and ranged from 14*s.* 6*d.* to 19*s.* according to quality.

Swansea's New Dry Dock.—The new dry dock of Palmer's Shipbuilding and Iron Company, Limited, which will be capable of taking the largest vessels visiting the port, is nearing completion, and is to be officially opened by Lady Pole, the wife of Sir Felix Pole, general manager of the Great Western Railway Company, on May 14 next. Provision has also been made for the future extension of the dock if necessary. It has been built on a site in the King's Dock which was reserved for such purposes, and is 560 ft. long, with a depth of 75 ft. at the entrance, and a depth of 26 ft. on the sill. In addition, a repairing berth is to be constructed for vessels afloat with a jetty 760 ft. long. The new dock is constructed entirely of concrete with the exception of the quoin and sill stones, which are of granite. The gates are of steel in two leaves, and the keel blocks on which the vessels will rest are made in groups.

Iron and Steel Trades.—Exports of iron and steel goods from the South Wales ports last week amounted to 7,696 tons, which was the smallest quantity shipped in any similar period this year, with the exception of the week ended March 7. Shipments of tinplates and ternplates amounted to 6,151 tons, compared with 4,799 tons in the preceding week; blackplates to 515 tons, against 3,411 tons; galvanised sheets to 974 tons, against 549 tons; and other iron and steel goods to 56 tons, against 3,008 tons.

THE LATE MR. WM. INGHAM, M.INST.C.E.—We have received news from Johannesburg of the death, on March 7, of Mr. William Ingham, of the Rand Water Board. Mr. Ingham was born in Burnley, Lancs, in 1867, and obtained his training as a civil engineer in his native town. After a period as Resident Engineer of the St. Helen's Tramways, he was appointed assistant Water Engineer to Plymouth, and after four years' service he became Chief Engineer to Torquay Waterworks. Mr. Ingham went to South Africa in 1903 as Hydraulic Engineer to the Port Elizabeth Municipality, and subsequently went into private practice, doing important work for the Smartt Syndicate Irrigation Scheme at Britstown. He joined the Rand Water Board as Chief Engineer in 1910, and designed and constructed the great Barrage for the Vaal River water scheme. Besides being a member of both the Institution of Civil Engineers and Institution of Mechanical Engineers, he was a member of the Institution of Municipal and County Engineers, the Association of Water Engineers, and was a past president of the South African Institution of Engineers.

CONVERSION OF ALUNITE TO ALUMINIUM SULPHATE.—Metallurgists of the United States Department of the Interior, attached to the Pacific Experiment Station of the Bureau of Mines, Berkeley, California, have conducted successful small-scale tests on the bureau's new process for conversion of alunite, a mineral consisting chiefly of potassium and aluminium sulphates, into alum and aluminium sulphate. The apparatus constructed for these tests has a capacity of 100 lb. of alunite per charge. After the alunite is rendered soluble, the solution is treated for potash alum, and a good grade of iron-free alum is obtained by direct crystallisation. Further work is being done by the Bureau of Mines' investigators to develop the procedure for recovering alum to still higher efficiency, and for recovering aluminium sulphate after the alum has been removed. When these details are worked out, a plant having a capacity of one ton will be erected. The chief object of this work is to develop a simple method of preparing aluminium sulphate solutions free of impurities, such as iron, from impure clays or clay-like deposits, and thus provide a much-needed cheap process for the manufacture of pure alum and other aluminium salts, which now cost twice as much as the less pure salts.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night at 7.30 p.m., at 39, Victoria-street, S.W.1. Lecturette "Electric Lighting in Churches," by F. H. Taylor. Friday, May 9, at 7.30 p.m., "Methods of Purifying Water and Sewage," by F. W. Follett.

THE SOCIETY OF CHEMICAL INDUSTRY: CHEMICAL ENGINEERING GROUP. To-night at 6.30 p.m., at the Engineers' Club, Coventry-street, W.1. Annual General Meeting.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Saturday, May 3, at 4 p.m., in the College of Technology, Manchester. "Non-magnetic Cast Iron," by Mr. S. E. Dawson.

THE INSTITUTE OF TRANSPORT.—Monday, May 5, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. "Scientific Research and Transport," by Professor F. C. Lea, O.B.E., D.Sc.

THE SOCIETY OF ENGINEERS.—Monday, May 5, at 5.30 p.m., at the Geological Society, Burlington House, Piccadilly, W. "Some Factors of Sea-Defence Work," by C. H. J. Clayton, M.Inst.C.E., F.G.S.

THE ROYAL SOCIETY OF ARTS.—Monday, May 5, at 8 p.m., at John-street, Adelphi, W.C.2. Extra meeting. "Photography in Industry, Science and Medicine," by T. Thorne Baker. Wednesday, May 7, at 8 p.m., ordinary meeting. "Wireless Navigation of Ships and Aircraft," by J. Robinson, M.Sc., Ph.D. F.Inst.P.

THE INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Wednesday, May 7, at 6 p.m., at Savoy Place, Victoria Embankment, W.C.2. "Faithful Reproduction in Radio Telephony," by L. C. Pocock.

THE OPTICAL SOCIETY.—Thursday, May 8, at 7.30 p.m., at the Imperial College of Science and Technology, South Kensington. "The Preparation of Coppered Glass Mirrors," by E. A. H. French. "The Taylor-Hobson F/2 Anastigmat," by H. W. Lee, B.A.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, May 9, at 6 p.m., at Storey's Gate, S.W.1, general meeting. "Irrigation Pumping Machinery (Gezira Scheme), Sudan," by Richard W. Allen, C.B.E.

THE IRON AND STEEL INSTITUTE.—Annual Meeting.—Thursday, May 8, and Friday, May 9, at the Institution of Civil Engineers, Great George-street, S.W. 1. Thursday, May 8, at 10.30 a.m. Presidential Address. Presentation of the Bessemer Medal to Professor Albert Sauveur. Papers to be read and discussed:—"Continuous Rolling Mills, their Growth and Development," by J. P. Bedson. "High Temperature Growth of Special Cast Irons," by J. H. Andrew and H. Hyman, at 2.30 p.m. "The Plastic Deformation of α and γ Iron," by F. C. Thompson and W. E. W. Millington. "The Effect of Cold Work upon the Density of α Iron," by H. O'Neill. "The Production of large Crystals by Annealing Strained Iron," by C. A. Edwards and L. B. Pfeil. "X-Ray Studies on the Crystal Structure of Steel," Part II, by A. Westgren and G. Phragmén: at 7.15 p.m. for 7.30 p.m. Annual Dinner in the Grand Hall, Hotel Cecil, Strand, W.C. 2. Friday, May 9, at 10.30 a.m., "Recovery of Waste Heat in Open Hearth Practice," by W. Dyrssen. "Theoretical considerations respecting certain features in the Working and Efficiency of Reversing Regenerators," by J. Seigle. "On the Forging Temperature of Steels," by K. Honda. "On the Indentation Hardness of Metals," by K. Honda and K. Takahasi. "Experiments on the Brinell-tensile relationship," by A. L. Norbury and T. Samuel. "Transverse test bars and Engineering Formulæ," by G. S. Bell and C. H. Adamson. "The Hardening of Silico-Manganese Steels," by E. W. Colbeck and D. Hanson. "Hardness of Electro-deposited Iron, Nickel, Cobalt and Copper," by D. J. Macnaughtan. "Notes on the Testing of Metal Strip," by L. Aitchison and W. L. Johnson. "Some Effects of the Penetration of Arsenic and Sulphur into Steel," by W. N. Hindley.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, May 9, at 9 p.m. The Evening Discourse will be delivered by Professor V. F. K. Bjerkres, on "The Forces which Lift Aeroplanes."

WINCH AND CAPSTANS FOR URUGUAY.—The British Vice-Consul at Montevideo has reported that the Port Authorities in Montevideo are calling for tenders for the supply, delivery and erection of one electric winch capable of hauling boats of 600 metric tons, and two electric capstans of a hauling capacity of 8 metric tons at a circumferential speed of 10 to 15 metres per minute. Tenders are to be presented on June 17 and local representation is essential. United Kingdom firms desiring further particulars should apply to the Department of Overseas Trade, 35, Old Queen-street, S.W.1, quoting reference 9234/F.L./E.C./A.(2).

INSTITUTION OF NAVAL ARCHITECTS.—The summer meeting of this institution, to be held jointly with the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, is to commence in London on June 25, at 10 a.m. by the reading, and discussion of papers in the hall of the Institution of Civil Engineers; on June 26, a visit is to be paid to the British Empire Exhibition. On June 27, there is to be a further reading and discussion of papers and a trip on the Thames to the docks and shipping in the Port of London. On June 28, there will be a visit to Windsor Castle. On June 30 and July 1, visits will take place on the Clyde, and on July 2, visits to shipyards and works at Newcastle.

HYDRAULIC FIRE LADDER FOR RANGOON.

CONSTRUCTED BY MESSRS. MERRYWEATHER AND SONS, LIMITED, ENGINEERS, GREENWICH.

(*For Description, see Page 575.*)

FIG. 4. FIRE LADDER IN TRAVELLING CONDITION.

FIG. 3. ELEVATING MECHANISM.

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TELEPHONE NUMBERS—3663 and 8598 GERRARD.

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"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

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TASMANIA: Gordon & Gotch Prop'ty, Ltd., Launceston: Hobart.

UNITED STATES: For Subscription, New York: W. H. Wiley, 440, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church-street, New York.

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ENGINEERING.

FRIDAY, MAY 2, 1924.

THE PROPERTIES OF STEAM.

THE present trend towards the adoption of very high steam pressures and temperatures renders existing steam tables inadequate, and this has been recognised both in this country and America. With the assistance of the "Beama" Professor Callendar is, accordingly, extending to high pressures his measurements of the total heat and of the specific heat of steam. The latter he is able to determine directly by means of his most ingenious and very accurate differential throttling calorimeter. The special apparatus required has now been completed, so that precise figures should soon be available in a region where really reliable observations have so far been lacking. In America a very comprehensive research on the properties of steam is also in progress, and it may be observed that American engineers have a historical interest in this matter, since until the masterly investigations of Regnault, the best available data, as to the temperature of saturated steam, were probably those provided by experiments made by a committee of American engineers. Part of the new work contemplated will be carried out at the Bureau of Standards, an institution which has acquired an international reputation both for the ingenuity of its methods and the precision of its results. It was here that the error in the Reichsanstalt determinations of the E.M.F. of the Clark cell was first demonstrated. Another part of the research on steam closely analogous to that which Professor Callendar has in hand is being undertaken at Harvard.

The experiments to be made at the Bureau of Standards appear to be of a novel type. The procedure proposed is to heat electrically different weights of water in a container, carefully heat insulated; the volume of this will be accurately measured. Part of the electrical energy supplied will, of course, go to heat up the container itself, and the rest to raising the temperature of the water and generating steam. By a differential method the correction, which would otherwise be required for the heat capacity of the container, will be eliminated, and an equation can then be found connecting together the total heats and densities of the water and of the steam, and the differences between the heat supplied, and the weights present in the differential experiments. In the next place a certain weight of steam will be withdrawn, the temperature of the container being maintained constant during the operation by a supply of electric energy which will be accurately measured. Finally this experiment will be repeated, with the exception that water will be withdrawn in place of steam. Analysis shows that the three series of experiments made at any stated temperature will make it possible to deduce the total heat of water at this temperature, the latent heat of the steam and the ratio of the specific volume of the steam to the specific volume of the water. In view of the efficiency with which it is now practicable to heat insulate vessels, and of the extraordinary precision with which electric energy can be measured, a high order of accuracy is anticipated in the final results.

The Harvard experiments are, as already indicated, being made along the lines originated by Professor Callendar. The cooling effect produced when steam is wiredrawn from a higher to a lower pressure is being measured and specific heats deduced therefrom in the usual way. From an interim note on the subject published by Professor H. M. Davis in the February issue of *Mechanical Engineering* it appears that these experiments, so far as they have gone, corroborate Callendar's statement* that the specific heat of steam at zero pressure is not quite constant, but increases with increasing temperature. This result, though it is the reverse of unexpected, does indicate once again the certain malignity in inanimate objects on which a German philosopher has so feelingly commented. It would be very much more convenient if steam molecules would consent to behave purely as simple elastic solids devoid of any internal structural peculiarities. As matters stand, it will probably prove necessary in practice to represent the properties of steam by different formulas according as we are dealing with very high or with ordinary pressures and temperatures. It will be of importance to learn up to what limits Callendar's compromise of adopting a mean value for this "zero" specific heat can be carried, without the introduction of really material errors. Of course it is always possible to construct empirical formulas to cover any set of consistent experiments, no matter how wide the range, but formulas of this type are not only highly unsatisfactory from the philosophic standpoint, but in this instance are pretty certain to be too complicated to be of real practical value. Perhaps the worst example extant of the laborious construction of such meaningless empirical formulas is that devised to represent Regnault's experiments on the temperature of saturated steam, which was published by the International Bureau of Weights and Measures in 1897. This formula contained no less than seven empirical constants which were each calculated to nine significant figures. Not one of them had the least physical significance.

No doubt the objection to complicated empirical formulas can be partially mitigated by the preparation of extensive tables and charts, but for many purposes these fail to meet requirements, and the objection to the meaningless character of the coefficients involved is unaffected. Formulas with a rational basis in which a definite physical interpretation can be placed on each and every coefficient used, have some very marked advantages. They can generally be extrapolated with some confidence, and, moreover, the user is able to visualise the effects of changing conditions in a

* See "Properties of Steam," page 98.

way otherwise impracticable. No doubt this counsel of perfection sets forth an ideal not always attainable owing to our inadequate knowledge of the mechanism involved in physical phenomena. In such cases, and unfortunately they are far from few, the best that can be done is to see that the purely empirical formula, then unavoidably adopted, is dimensionally correct. Where, however, it is practicable to picture the intimate nature of the phenomena, it is certainly desirable to frame formulas with this model as a basis.

In this connection it may perhaps be noted that it is not altogether easy to visualise the condition of a gas at zero pressure, and to picture the interchanges of energy between it and sources of heat. If the pressure be zero, each individual molecule must be regarded as completely isolated from its fellows. This condition is very much that of a molecule in interstellar space, and, indeed, is quite fairly represented by that of the residual gases in some modern X-ray bulbs. There are no molecular collisions, and, *a fortiori*, no co-aggregation into double or multiple molecules. Any change in the specific heat of a gas under these conditions must accordingly be due solely to the internal structure of its individual molecules. It is, of course, this very fact which is responsible for the theoretical importance of this specific heat at zero pressure. Naturally it cannot be directly measured but must be deduced from experiments made at finite pressures.

It has been customary to say that when heat is supplied to a gas, part of it goes to increase the "translational" energy of the molecules, and part to increase the rate at which they spin, whilst the remainder is commonly said to be expended in increasing the internal "vibratory" energy of the molecules. There has, however, been considerable difficulty in specifying the precise nature of this vibratory energy. If it were an ordinary mechanical vibration, mathematicians assure us, that each different type of such an internal vibration would absorb one-third as much heat as was expended in increasing the translational energy of the molecules, and the total specific heat of every gas would be very much higher than it is actually found to be. Indeed, at ordinary temperatures the energy absorbed in these internal vibratory motions is remarkably small, and it has been difficult to picture how this peculiarity comes about.

It would seem, however, that the work done during recent years, on the constitution of the atom and the molecule, does make it possible to conceive of a model, which qualitatively at any rate, will account for the actual facts, though whether the scheme will successfully stand quantitative discussion must be left for the mathematical physicist to decide. If the energy absorbed is not vibratory in the ordinary sense, but is converted into an incipient ionisation, the doctrine of the equipartition of energy between all possible degrees of molecular freedom would seem no longer to apply. In such incipient ionisations, a quantum of "radiation" energy is absorbed and converted into potential energy, by the lifting of an electron from its normal level in the atom, to one or other of Bohr's "stationary" orbits. The electron thus displaced remains at its new level for a minute interval of time. When it returns to its normal level, the potential energy due to its displacement will be radiated away, and there will be no accumulation of energy in this "degree of freedom," such as would be required to satisfy the doctrine of equipartition. Moreover, the return of an electron to its normal level is, as already stated, subject to a certain delay. Whilst its displacement lasts, the internal energy of the atom or molecule is increased by the corresponding potential energy. The stronger the radiation, the greater the number of such displacements, and this would seem to afford a physical explanation of the increase of the internal specific heat of a gas with rise of temperature.

It would further seem as if this mechanism would also provide for the conversion of radiant energy into energy of translation and rotation. As is now well known, light exerts a pressure upon every body by which it is either reflected or absorbed. Astronomers tell us that in favourable conditions this pressure is so great that in a star having five times the mass of the sun, the radiation pressure may balance nearly one-half of the gravitational attraction of its constituent parts. When an atom absorbs radiation with the consequent displacement of an electron, a pressure due to the destruction of the momentum of the ray acts on the atom, and will tend to accelerate it. When the electron returns to its normal position a fresh ray is emitted, and were there no time interval between the displacement and the return, this ray would be identical with that absorbed, and the reaction, due to generating the momentum of the emitted ray, would exactly cancel the effects of the preceding absorption, so that there would be no net thrust or torque on the atom concerned. Owing to the slight delay in the return, however, there will in general be some residual effect, so that the emitted ray is not in the same direction as the first, nor, indeed, will it have the same wavelength, if the velocity of the atom has materially changed in the interval, as might perhaps be the case if a collision occurred during the period the electron remained in its displaced position.

THE UNEMPLOYMENT INSURANCE (No. 2) BILL.

SUCCESSIVE Ministers of Labour have protested against the use of the popular word "dole" in connection with unemployment insurance. So far as covenanted benefit is concerned the protest is entirely justified, but "dole," if a somewhat unsympathetic expression, is a fairly apt and vigorous substitute for the official term "uncovenanted benefit." The National Insurance Act, 1911, brought into being a real scheme of insurance against unemployment, the principle being that employers, employed and the State were to contribute to the Unemployment Fund, and employed contributors who became unemployed were to be entitled to payments of benefit from the Fund, corresponding roughly to the number of contributions which they had made to it. The post-war depression in trade made necessary the payment of uncovenanted benefit from the Fund, *i.e.*, benefits paid to persons who had no contributions to their credit or had drawn all the covenanted benefit to which they were entitled. The Acts providing for these payments were of a temporary nature, and the Ministers who found themselves obliged to introduce them always looked forward to the time when such payments could be discontinued and the Unemployment Fund could be administered in accordance with the original scheme. The Government, in the Unemployment Insurance (No. 2) Bill, which they recently introduced into the House of Commons, propose to make the payment of uncovenanted benefit a permanent feature of the Unemployment Insurance Scheme. It is even proposed that, taking covenanted and uncovenanted benefit together, benefit may be paid in all for 52 weeks in each benefit year, more or less irrespective of the number of contributions paid. This is in effect to graft State maintenance permanently on to State insurance.

Another feature of the Bill which is open to grave objection is the proposed removal or modification of the existing trade dispute disqualification. Under Section 8 (1) of the Unemployment Insurance Act, 1920, persons thrown out of work owing to a stoppage of work due to a trade dispute at the premises at which they were employed are, in general, disqualified from benefit so long as the stoppage of work continues. The Labour Party objected strenuously to this in 1911, and have objected ever since. It was maintained on behalf of the Government in 1911 that the Fund should be applied for the benefit of contributors who were thrown out of employment on account of trade fluctuations, and should not be applied in relief of those thrown out of employment as a result of trade disputes. Against this the Labour Party maintained that it was hard that insured contributors who were the victims of trade disputes to which they were not parties and over which they had no control should be disqualified for the time being from benefits from the Fund to which they had contributed. This is a plausible argument, but for various reasons successive Governments have been unable to give effect to it. Most labour disputes relate to wages or working conditions, and although in a given establishment the cudgels may be taken up by only a section of the men, the others usually stand to gain or lose according to the result of the contest. It would be easy for the Unions to withdraw a few "key" men and bring an industry to a standstill and throw the burden of the maintenance of their members on to the Unemployment Fund. Further, a Union whose members were in receipt of benefit from the Fund might be financing the Union whose action had thrown their members out of employment. Repeated efforts to find a formula satisfactory to all parties have failed, and the Government proposes airily to remove the disqualification in cases where the insured contributor proves that he is not participating in the trade dispute which caused the stoppage of work and does not belong to a grade or class of workers, members of which are participating in the trade dispute. This is indeed to cut the knot without untying it. The employers at present contribute more to the Unemployment Fund than either the workers or the State, and they are entitled to be safeguarded against the risk of the Fund to which they contribute being applied, when trade disputes occur, for the benefit of those who are opposed to them in the disputes. We hope that employers generally will realise in time the danger to the whole scheme of unemployment insurance which is involved in the Government's proposals.

SCIENCE AT THE BRITISH EMPIRE EXHIBITION.—I.

AMONG the primary purposes of the British Empire Exhibition is to take stock of Imperial resources. The history of modern science has shown that up to now British scientific men have ranked very high as pioneers in scientific discovery, and no such stocktaking of resources as is intended at Wembley would be satisfactory which did not illustrate the place of Great Britain in scientific research. In the industrial exhibits are to be found manufacturing consequences of such work, though in its material applications other countries have often been more astute and alert than Great Britain. Doubtless the failure to make the earliest and most ample use of the results of scientific discovery has been unfortunate for our industries, and it is gratifying to know that in this respect the temper of those who now lead industry is more generally enlightened than it was. But in the long run the parent activity of research itself is of no less consequence than readiness to apply its results; and an essential and indeed fundamental part of the national exhibits lies in such as are concerned with the progress of research in pure science, and of the instruments and methods for carrying it on.

The number and variety of the researches in question is evidently too great to allow all to be exhibited, and at the request of H.M. Government a committee of the Royal Society has organised the choice and collection of those that are shown. It is as well that the responsibility of deciding what is, and what is not, appropriate to an exhibition of advances in the pure sciences should rest on shoulders so authoritative. Apart from the decision of what great sciences should be altogether omitted, delicate questions must have arisen of distinction between pure and applied science, and no wiser course could have been imagined than to leave such matters to be settled by the oldest and most eminent of existing societies for the cultivation of pure science. The progress from pure science through enlarged and perfected methods to industrial applications is gradual, and there is much border-line work that could be held to belong to applied science as well as to pure.

The choice that has in fact been made has been based on no pedantic distinctions, such as would have excluded appropriate work because it has industrial applications, but it has brought into due relief the essential character of research into pure science, which is that it seeks the attainment of knowledge and not the satisfaction of industrial or other material needs. Except to such extent as

it involves self-sacrifice and enjoins an exacting standard of accuracy, there is no intrinsic virtue in the practice of pure science, nor does its cultivation at all disparage research in applied science, which seeks to use existing knowledge in satisfying practical purposes. The importance of cultivating pure science lies in two fundamental facts, one naturally evident, and the other accredited by the experience of centuries, and in particular of the last century. In the constant endeavours to turn the forces of nature to the better account of man increased knowledge must give increased chances of success; and in the experience of the greatest industries their advance—sometimes even their creation—has begun by using the results of researches in pure science. If Nature had been simpler it might have been as profitable to seek such advances by investigating the problems of practice directly. As things are, it has been found expedient to precede or supplement the search by sedulously enlarging the general field of knowledge without thought or regard for the time being to what use may be made of the result.

The pure sciences represented in the exhibition are physics, geo-physics, some branches of biology, and chemistry. The exhibits in chemistry and allied parts of physics are shown in the Palace of Industry (Stand A 41), among the exhibits of the entire chemical industry organised by the Association of British Chemical Manufacturers, and part of the physical exhibits are shown by the National Physical Laboratory in the Palace of Engineering on space (Stand 13, Avenue 7-8, Bay 28-29) provided by the British Engineers' Association, together with other exhibits illustrating applications of physics to engineering. With these exceptions the Royal Society's exhibit is shown in Galleries 3 and 4 of H.M. Government Pavilion, where also are a few exhibits illustrating the applications of some physical researches to engineering.

The largest part of the collection is devoted to physics, and although it includes some applications to practice, its main purpose is to trace the history of the most important modern discoveries from their earliest stages, in some instances including the latest developments of inventions to which they have led. Before referring in detail to individual researches so illustrated it may be convenient to give an outline of the ground that the exhibits cover.

Two exhibits go back into history that is no longer modern. One of these, contributed jointly by the Science Museum, the Royal Institution, and King's College, deals with electrical science, and begins with Faraday's work at the Royal Institution. Its results are well known, but the exhibition of the simple apparatus with which he worked implies more clearly than could easily be expressed in words how remote his researches were from any conscious practical objective, though the great electrical industries, and indeed the electrical methods of investigation on which modern physics is based, are derived from them in direct sequence. It includes the original apparatus by which in 1831 Faraday demonstrated the generation of electric from magnetic energy, in 1837 his work on specific inductive capacity, and in 1857 his experimental work on the relation of gold in thin films to light. Other exhibits include Wheatstone's first bridge, resembling very closely the well-known text-book diagram; and coils used by Henry in his original experiments on self-induction of currents (1830–32), which he left with Wheatstone at King's College in 1837. From the 'seventies are a number of the original microphones made by D. E. Hughes in 1878 and 1879, from which the transmitter of the present day has been developed, and specimens of Graham Bell's early telephones and a transmitter. This exhibit is completed by specimens of the double oscillograph (1897), thermo-galvanometer, and bifilar vibration galvanometer, designed by W. Duddell for high-frequency alternating-current measurements.

A joint exhibit by the Science Museum and the Royal Institution shows a facsimile of Sir Isaac Newton's original reflecting telescope, made with his own hands in 1671, and now in the possession of the Royal Society. Another set of exhibits with historical interests are Joule's apparatus for determining the mechanical equivalent of heat, reproduced from the originals in the Science Museum, including the weight-driven water calorimeter, the cast-iron frictional apparatus which ran in mercury, and an electro-magnet rotating between the poles of a powerful magnet in a tube filled with water. Two exhibits of Davy's work include a variety of examples showing the complete evolution of his safety lamp, and two of the battery troughs that he used in separating metallic potassium and sodium by electrolytic decomposition of the caustic alkalies. These historical exhibits have truly been available elsewhere for those who sought them; but their lesson is not the less impressive now that they have been collected in a more frequented place, and shown in context with some of the modern results to which they have led.

Of these results the most far-reaching is perhaps the "fourth state of matter" that Crookes exhibited in a high-vacuum tube in 1878, and J. J. Thomson in 1897 found to behave as though it consisted of ultimate particles of constant mass, each charged with the same quantity of negative electricity. Some of Crookes's original apparatus is shown; and among other exhibits Sir J. J. Thomson shows the apparatus by which he himself detected the existence of the electron particles, charged with negative electricity, and measured their mass and velocity. This exhibit is supplemented by that of Mr. C. T. R. Wilson, illustrating with the help of an apparatus made and contributed by the Cambridge and Paul Instrument Company, Limited, Mr. Wilson's method of making visible the path of ions, positive and negative, by using them as nuclei for condensing moisture in a supersaturated dust-free atmosphere. Like Sir J. J. Thomson's exhibit, Mr. Wilson's is demonstrated from time to time in actual operation. An allied exhibit is that of Professor H. A. Wilson, which shows the actual apparatus by which he succeeded in measuring the charge on each electron by controlling the rate of fall of charged drops with an applied electric field.

The application of "Canal Rays" to the determination of atomic weights, which has led to such remarkable results, is also represented in Sir J. J. Thomson's exhibit. It includes, for instance, photographs illustrating his method of positive ray analysis, on which appear the parabolas that disclosed the existence of the three-atomic variety of hydrogen (H_3) and the two varieties of neon, demonstrated by him in 1912. Allied to these is the exhibit of Dr. F. W. Aston, in which are shown his micro-balance and mass spectograph, with details of the stages by which he succeeded in determining directly the weight of individual atoms, and in demonstrating for a large number of elements the existence of isotopes—substances chemically and in all other experimental aspects identical with the element but differing slightly from it in the mass of its individual atoms. The results of this method give direct experimental confirmation of the view that the atoms of all elements are themselves built up of atoms of electricity; but the method is also important as providing a means of chemical examination of the same type as spectroscopy, but vastly more delicate. With it quantities can be detected that are too small to be identified by spectroscopical examination, and it depends on phenomena taking place in so minute a time—of the order of a millionth of a second—that it is hoped by its means to be able to follow the course of chemical reactions of which at present only the final results are known. The mass spectograph exhibited is contributed by Messrs. Adam Hilger, Limited, who also have provided most of the apparatus that show the means of measuring wave lengths of all types, from the γ and the X-rays, of which the wave length is 7×10^{-6} micro-millimetres through ultraviolet, visible, and infra-red rays up to "rest-strahlen" of about 100 μ length, and thence to electric waves of length extending from 2,000 μ to perhaps 50,000 metres, of which the frequency is determined by Mr. Dye's multi-vibrator. By means of the last instrument, the tuning fork and the astronomical clocks these frequencies are connected with the period of the earth's rotation round its axis, as illustrated by Prof. Sampson's chart.

The electronic conception of the structure of matter and the mechanism of electrical action has fructified in many different directions, which other exhibits illustrate. One line, which has led to the widest practical applications, is the observation that electrons—now recognised as ions—may be emitted by hot bodies. As will be remembered, Edison found in 1883 that from a metal plate sealed into an incandescent lamp between the legs of the carbon filament a current would pass to the positive pole of the filament when it was made incandescent by a continuous current, but not to the negative pole; and Fleming showed shortly afterwards that this effect arose in some way from the emission of streams of particles from the filament, which conveyed a charge of negative electricity to the plate, but not in the opposite direction. These peculiar phenomena remained, however, absolutely sterile of any practical application until they had been fertilised by Sir J. J. Thomson's demonstration of the electron in 1897, followed by the discovery that the filament of an incandescent lamp emitted large quantities of electrons in all directions. In this way Fleming was led to make an arrangement similar to Edison's for the purpose of rectifying the rapid oscillations of wireless telegraphy, with the object of enabling them to be detected on a telephone; and on this followed the developments by which the thermionic valve was adapted, not only to receive electric oscillations and convert them into uni-directional currents that can be recognised on a telephone, but also to magnify and even to generate them, besides serving as peculiarly sensitive and powerful relays in ordinary telephone work, and thus enormously extending the range of telephonic speed or reducing the weight of conductors required for a given range. With contributions from the Marconi Companies and the Mullard, Edison and Swan, and British Thomson-Houston Companies, Professor Fleming's exhibit includes specimens of thermionic valves, from his original rectifying valve to the latest patterns in industrial use, and furnishes a concrete example of an industrial development of the first magnitude, which owes its existence to purely scientific and theoretical investigations, made without any sort of practical objective in view. Intermediate in logical interest between the exhibits of Sir J. J. Thomson and Professor Fleming is that of Professor O. W. Richardson, consisting of the originals and facsimiles of the actual apparatus used in his experiments between 1900 and 1913, by which he determined the total electron emission from certain metals at various temperatures and the relation of its amount to the temperature, the effects of gases on the emission, and the other principal phenomena of thermionic emission.

Other lines of investigation allied to the study of the constitution of electricity and matter deal with radio-activity, the origin of spectra, and X-rays. Sir Ernest Rutherford contributes an exhibit on some aspects of radioactivity and their bearing on atomic structure, in which he records the means that led to the detection of the emanation, the discovery of the nature of α particles, the methods of counting them, the conditions in which they can be scattered by matter, the artificial disintegration of elements, the β and γ-rays from radio-active substances, and the work of Moseley on the atomic numbers of the elements. Prof. Fowler and others contribute an important series of exhibits dealing comprehensively with the origin of spectra, and the principal apparatus and methods for examining them, instruments being contributed by the Cox Cavendish Electrical Company, Limited, the White Electrical Instrument Company, Limited, Messrs. W. G. Pye and Company Limited, and Messrs. Adam Hilger, Limited. Prof. Barkla exhibits reproductions of the apparatus by which he discovered the scattering and polarisation of X-rays and the fluorescent line spectra in X-rays that characterise each element. Sir William Bragg and Prof. W. L. Bragg contribute an exhibit illustrating the application of X-rays to the analysis of crystal structures, including a Bragg Spectrometer in which the intensity of the rays reflected at a crystal face is measured by means of an ionisation chamber that can be revolved about the axis of the instrument (contributed by Messrs. Pye), and a Müller Spectrograph, which records the reflected rays photographically (contributed by Messrs. Hilger). In addition to some photographs obtained with the latter instrument models are shown representing the atomic structure of a number of elements and inorganic crystals, and

some, not so completely worked out, of crystals of organic substances. Part of this exhibit is to be found in the Scientific Section of the Chemical Hall in the Palace of Industry, where the National Physical Laboratory is also exhibiting apparatus relating to the X-ray analysis of crystal structure, and results obtained with it, shown with models. Demonstrations are given from time to time of all these important and interesting exhibits, with the the exception of Prof. Barkla's.

The National Physical Laboratory is also among the principal exhibitors of apparatus relating to fine measurement. It shows diffraction gratings, ruled on a Blythswood Ruling Engine on blanks supplied by Messrs. Hilger, both plane and spherical, with radius from 1 to 3 metres, and to finenesses up to 28,800 lines per inch, and a variety of typical apparatus for measuring distances to an accuracy up to a millionth of an inch. Other apparatus for similar purposes, some designed by Messrs. Sears and Brookes, of the Laboratory, are exhibited by the Pitter Gauge and Precision Tool Company, Limited, and the London Electric Wire Company, and Smiths, Limited, exhibit the Lewbeck projecting micrometer, by which diameters can be read to an accuracy approaching one fifty-thousandth of an inch. Prof. Whiddington also shows an "ultra-micrometer," in which he measures change of length by change in the capacity of a parallel plate condenser, indicated by change of frequency of a high-frequency oscillation maintained by a three-electrode thermionic valve in an inductance circuit containing the condenser. The instrument is intended only to indicate changes of about one-tenth of the millionth of an inch, but it has been found that with another design of instrument changes as small as one two-hundredth of the millionth of an inch can be detected. The exhibits will remain on view only until June 15. Other instruments for fine measurement are included in the Laboratory's exhibit of the application of physics to engineering in the Palace of Engineering.

Metallurgical exhibits by the National Physical Laboratory are shown in the Chemical Section, and include metallographic specimens (microstructure and crystallisation), models showing the constitution of ternary alloys, a carbon-ring electric resistance furnace (half size model) used for research up to 2,500 deg. C., refractories, and standardised samples of steel and cast iron issued jointly with the Iron and Steel Institute. Other exhibits of the Laboratory, include specimens resulting during the course of the research on cutting tools undertaken for the Institution of Mechanical Engineers, specimens and photographs illustrating researches on the formation of slip bands and on the fatigue of metals, specimens of aluminium alloys and of castings in graphite moulds, pyrometers, Sir Joseph Petavel's high-temperature high-pressure arc furnace, &c., and are shown in the Palace of Engineering.

Prof. H. C. H. Carpenter and Miss C. F. Elam show single-crystal test pieces of aluminium, and Prof. G. I. Taylor and Miss Elam show the distorsion of them when stretched, while Dr. F. S. Goucher, of the General Electric Company, Limited, shows the failure of a tungsten filament at a point at which X-ray analysis shows the filament to have consisted of a single crystal, and exhibits photo micrographs, models and diagrams illustrating the process of deformation.

Other exhibits of the National Physical Laboratory illustrate its methods of investigating viscosity and lubrication, the head resistance of projectiles, the permissible current loading of cables, and in the Palace of Engineering the heat conductivity of various building materials, and other matters on which it has published reports.

Mr. H. A. Thomas shows a new electric clock consisting of a simple pendulum, of which the swing is controlled by varying the effective resistance of a high-frequency oscillating circuit maintained by a three-electrode valve. Mr. F. Hope Jones sends a free pendulum without escapement or other duty of any kind and working in a vacuum. Its slave clock can be used to operate electrical impulse dials or make electrical contacts of any kind without affecting the free pendulum, even indirectly; and it is said to have measured time with greater accuracy than has been attained previously.

Among the astronomical exhibits are particulars of clock rates from the Royal Observatory, Edinburgh, illustrating the present position in regard to precision time keeping, and photographs shown by the Astronomer Royal of the results of the eclipse expedition of 1919, which were in conformity with predictions made by Einstein.

Other exhibits will be added or substituted at various dates from June 15 onwards.

The Chemistry Section provides a comprehensive series of exhibits dealing with purely chemical matters, of which the intention and the effect is to show the close relation in which pure science has stood to industrial manufacture. In addition to further models of crystal structure shown by Sir William Bragg and Prof. W. L. Bragg, it includes an exhibit by Prof. Smithells, showing some modern information in regard to the structure of coal, the manufacture of coal gas, and the processes of combustion. Sir Ernest Rutherford supplements his exhibit in the Government building by others on the same subject, lent by the Cavendish Laboratory, as do Mr. C. T. R. Wilson and Dr. F. W. Aston. Prof. F. C. Thompson shows models, illustrations, samples and photomicrographs exhibiting the effect of hot and cold working on crystalline structure, the mechanism of plastic deformation, and crystallisation of metals in relation to casting temperature. Prof. Hinchley shows models and examples of various typical elements of chemical engineering plant, and Dr. Hilditch shows a scale model of the United Alkali Company's plant for catalytic production of ammonia, together with a full size converter unit. Prof. F. G. Donnan has organised an inorganic and physical chemistry section, including a collection of apparatus and models from institutions in all parts of the country for a considerable variety of purposes; one notable contribution by the Royal Institution is a historical collection of the apparatus of Sir James Dewar. Prof. J. W. McBain has organised similarly a collection of exhibits by scientific workers on colloids, including one illustrating the filtration of colloids by the stream-line filter.

Sir Robert Robertson, the Government chemist, contributes models illustrating improvements in plant for the manufacture of explosives made between 1900 and 1914, and 1914 and 1924, respectively, with particulars of important researches during the same periods, showing in detail that necessity was a prolific mother of invention at Woolwich, as elsewhere. Part of these exhibits are lent by the Board of Trade, the Imperial War Museum, the Science Museum, and Messrs. Nobel's Explosives, Limited.

The Research Department at Woolwich also furnishes exhibits on the calorimetry of explosives, the Hopkinson pressure bar, and an electrical method of determining the detonation velocity of explosives.

FLUXES AND SLAGS IN METAL MELTING AND WORKING.

LAST Monday the Faraday Society and the Institute of Metals, in co-operation with the British Non-Ferrous Research Association and the Institute of British Foundrymen, discussed "Fluxes and Slags in Metal Melting and Working" in a joint meeting held in two sessions from 3 to 7.30 p.m. at the Institution of Mechanical Engineers. The chairmen were Professor T. Turner, President of the Institute of Metals, and Sir Robert Robertson, President of the Faraday Society. Though the discussion was restricted to metal melting, welding and soldering, as distinct from smelting, intrusions into the general domain of metallurgy were inevitable and frequent during the discussion.

Outlining in his introduction to the discussion the physical chemistry of fluxes and slags, Professor C. H. Desch stated that, apart from the steel and aluminium processes, our knowledge of these matters was mainly empirical. Fluxes and solders were used to dissolve the oxide films and impurities of the metals which prevented coalescence of the metallic particles, without attacking the crucibles, and additions were made to reduce the viscosity and melting point of the flux. Such additions might make the slag heavier than the metal and prevent its rising, as in the case of aluminium and still more of magnesium, because the molten magnesium had a higher expansion coefficient than the carnallite bath. Fluxes probably also acted by reducing the surface tension, and the liquid surface films might differ in their properties from the liquids underneath; but the inter-facial tensions were very difficult to study. It seemed now that even mercury would wet glass if the glass were freed from gas films. Manganese was regarded as a deoxidiser; but Giolitti had suggested that it promoted coalescence somewhat as electrolytes facilitated the coagulation of colloids. Gold would not wet tungsten, but did so when alloyed with a little platinum. The lead "fogs" forming in the electrolysis of fused lead chloride were suppressed by the addition of alkali chlorides (Lorenz). Dusty mercury globules would not unite until wetted. Thoria was purposely added to tungsten to minimise grain growth, and Tammann considered that any failure of grain growth, which he explained by reference to the lattice structure, was generally due to intergranular films. Professor Desch would not go so far, but he urged more systematic study of the phenomena.

Papers of a metallurgical character were first taken. A paper by Mr. A. Portevin, of Paris, on "Oxidising Fluxes in the Melting of Non-Ferrous Metals," read in abstract by Dr. R. S. Hutton, pointed out that fluxes generally used as reducing agents, might have oxidising effects. He had found certain bronze castings heated by the blow pipe always to be riddled with blow-holes, evidently due to reducing gases. To suppress these he had sprinkled 0·05 per cent. of red lead on the liquid bronze of copper, tin and lead (88 : 6 : 3), and this remedy for troubles caused by highly-reducing atmospheres had proved quite effective.

Messrs. R. Genders and M. A. Haughton, of Woolwich, gave a preliminary account of experiments on "The Origin and Properties of Slags in Brass Melting." Dry zinc oxide, they observed, was not wetted by the molten brass to which they added it. In the presence of fluxes, however, crystalline inclusions, partly at least consisting of zinc oxide and varying in appearance with the nature of the flux, were found in the brass. This was further studied in various experiments on the rate of the diffusion of impurities of zinc oxide and sulphide in brass heated to 1,100 deg. C. Given time, these impurities would rise, especially when the bath was stirred, and brass-alloys did not in general contain more non-metallic inclusions than ordinary steel did.

Troubles with highly-viscous "Slags of Silver Alloys" were the subject of a paper by Mr. John Phelps, of the Royal Mint. The silver-nickel-copper alloy (50 : 40 : 10) which they used in 1920–22, melting above 1,180 deg. C., had to be poured at 1,250 deg., whilst silver-copper alloys were generally poured at 1,050 deg. Oxidation was prevented by the addition of metallic manganese and phosphor copper (0·05 per cent. of each) to the pouring ladle, which was a crucible provided with a vertical club-shaped stirrer, made of graphite and clay like the crucible. This stirrer, which was grooved longitudinally and spirally and was revolved at 120 r.p.m., had proved generally serviceable. Owing to the fluxing of the highly-siliceous cover with the charcoal ash and other dust, a slag was produced which was very viscous and contained nearly 5 per cent. of silver. A flux richer in manganese and poorer in phosphorus gave a slag richer in silica and more fusible, which contained very little silver; still more fusible slags might have been obtained by the aid of sand or glass, but in Mint practice a viscous slag was more readily excluded from the castings—a point not further explained in the paper.

The "Notes on Slags from Lead, Copper and Other Blast Furnaces," which Mr. Gilbert Rigg, consulting chemist to the Zinc Producers' Association of Australia, had sent in, referred to the difficulty of drawing conclusions from the properties of the slag after its withdrawal from the conditions under which it originated and reacted in the furnace. Manganese-spiegel slags frequently gave off carbon monoxide gas on cooling, but did not subsequently show any porosity or dissolved gas; yet the carbon monoxide gas had probably much to do with the reactions. The slag was mostly green and opaque,

and contained 5 per cent. of manganese, whilst the grey and blue glass of other slags contained 2 and 7 per cent. of Mn as MnO. The last-mentioned blue slag was highly siliceous, and it would appear that some basic slags were unable to retain MnO when cooling. Mr. Rigg gave further particulars concerning the complex reactions taking place in melting galena sinters. Professor Turner remarked that Mr. Rigg's observations on changes in cooling slags were of general importance, and these problems were now being studied in Birmingham.

An experimental contribution to the problems of "Sulphurising and Desulphurising of Metals by Basic Slags and Fluxes," communicated by Mr. B. Bogitch, of Paris, dealt with desulphurising of metals in the molten and the solid (agglomerated in briquettes) state. Powdered lime would take up sulphur from charges rich in sulphur, but not when little sulphur was present, unless the fluidity and solubility of the calcium sulphide was increased by the addition of calcium fluoride or chloride, by which means pure iron and nickel could be produced, at any rate in the laboratory, from sulphides. In the presence of carbon, agglomerated oxides could be reduced to metal in closed chambers, but the carbon must contain alkali carbonates, and anthracite was therefore unsuitable. Mr. Bogitch also explained how, with the excess of carbon necessary for sulphur removal, mattes could be blown in furnaces from silicates and oxides by melting them with calcium sulphide.

The next group of papers dealt with welding. There are two chief arc-welding processes. Banardos used a carbon electrode, chiefly for cutting and for filling up cavities; Slavianoff introduced a metal electrode for welding; in both cases the electrode is the negative pole, and special fluxes or coated electrodes are used to prevent air access. Mr. W. Spraragen, secretary of the American Bureau of Welding, giving in his communication on "Fluxes and Slags" a summary of American practice, pointed out that the coatings used consisted of asbestos yarn, of silicates and salts into which the electrode was dipped, of magnesium and boron suboxide, of aluminium paint and nickel plating and many other materials. At the Norfolk Navy Yard the lime residue from the calcium carbide of acetylene generators had been found useful for iron and steel electrodes. Monel metal was welded with the foundry flux of magnesium, manganese and silicon, to suppress blow holes; in bonding rails with copper wire, without first removing oxide skin, silicon was the reducing agent. In welding copper rods and rings the Lincoln Electric Company used carbon electrodes and brass scrap, the vapours of which maintained the arc; for long arcs the copper was deoxidised with a little aluminium or silicon. With respect to oxy-acetylene welding Mr. Spraragen referred to S. W. Miller's book. Mr. P. L. Robert subsequently gave information on the welding practice of British workshops.

Confining himself to "Fluxing Problems in Arc-Welding of Mild Steel," Mr. H. Ogden, of the Sir John Cass Institute, mentioned that fluxes should contain alkaline oxides of high thermionic emissibility to stabilise the arc, and expressed his agreement with Dr. H. Neese's* conclusion that, though flux-coated electrodes gave less sound welds than bare electrodes, their use facilitated the work of the welder upon whose skill so much depended. That was supported by J. Caldwell's tests carried out for the Research Committee of the Emergency Fleet Corporation, U.S.A., and others, and also by Mr. Ogden's experiments on the ductility and X-ray examination of arc-deposited metal bars 6 in. by ½ in. square, and further supported by other speakers.

Mr. C. Coulson-Smith, of Messrs. Allen-Liversidge, dealing in his paper on "Fluxes and Slags in Oxy-Acetylene Welding" with mild steel, cast iron and non-ferrous metals, pointed out, with respect to brass and zinc losses, that brass melted at 930 deg. C. and zinc volatilised at 940 deg. As aluminium flux he recommended mixtures of lithium chloride with potassium chloride, fluoride and bisulphate; the bisulphate decomposing at about 600 deg. into sulphate and sulphur dioxide would help to decompose substances like cryolite and calcium fluoride, formed in the reactions, at lower temperatures than that required to fuse the mineral or salt itself. For soldering aluminium, zinc-tin alloys containing also aluminium and sometimes phosphorus and copper were mostly used; the zinc-tin joints were mechanically satisfactory, but were corroded by boiling water.

The papers on aluminium presented by Dr. W. Rosenhain and Mr. A. L. Archbutt, "On Fluxes in the Melting of Aluminium and its Alloys," and Mr. A. G. Lobley, "Notes on Metallic Inclusions in Metals, especially Aluminium," gave rise to an animated discussion. Mr. Archbutt's statement that the re-melting of aluminium would not introduce oxide if the melting were conducted at the lowest possible temperature, without undue agitation and without fluxes if avoidable, was criticised by Dr. Seligman, Mr. Lobley, and others as being correct only for ideal conditions; but Mr. Archbutt insisted that their conditions had been ideal for oxidation. When fluxes were used contamination was difficult to avoid, and fluxes were undesirable also because the alkali fluorides and chlorides corroded the crucible; iron crucibles were attacked by the molten metal if not coated with a wash of lime and silicates. The aluminium-silicon alloys known as alpac, silumin, &c., were supposed to take up a little metallic sodium from the special patented fluoride flux; that sounded startling, but was in accordance with the fact that the fine, mechanically superior microstructure of aluminium obtained by the aid of this flux was also produced by adding a little sodium to the metal, in quantities insufficient to have deleterious effects; the old aluminium, reduced by means of sodium, had probably contained traces of sodium. As regards soldering, the National Physical Laboratory and the Bureau of Standards had found the use of fluxes to be undesirable. The case of welding seemed to be different. Pending patent litigation, unfortunately, stifled this discussion.

Mr. Lobley agreed with Dr. Rosenhain that aluminium contained less oxygen than most metallurgists believed; but if it once got there, it was very difficult to remove, and practically all obtainable aluminium had been remelted in reverberatory furnaces favouring oxidation and nitridation. His micrographs proved the presence of inclusions, probably cryolite, in the metal; cryolite seemed also to be soluble in aluminium. Zinc chloride was the best flux for re-melting the aluminium scrap. We might mention in this connection that a German competition committee last year awarded the first prize to an aluminium flux consisting of zinc chloride, calcium and lithium chloride and sodium fluoride, as giving good results with all the solders tested, but accorded only a second prize to a solder of zinc and cadmium (3 : 1); all the other solders were more complex, and the committee asked for further researches to be made on solders.

As regards "Fluxes in the Tin-plate Industry," Dr. T. Lewis Bailey, H.M. Chief Alkali Inspector, stated that the pickled sheets were at present passed into the tin bath through 3 in. or 4 in. of zinc chloride, and were then sent through a series of rolls working in palm oil in order to keep the tin in condition for removal. Palm oil had formerly been used as a flux, but it was difficult to understand its effect and the rationale of the flux action of zinc chloride.

Describing his experiments on "Fluxes for Soft Soldering," Mr. T. B. Crow, of Birmingham University, pointed out that soldering and alloying required wetting and interdiffusion of the two metals. If the oxidation proceeded at a slow rate, agents like tallow, keeping the air out, would answer best—such organic fluxes would hardly remove surface films and have any cleaning effect. He was studying these phenomena in an electric furnace charged with different atmospheres, by means of electrically heated electrodes. The fluxes did not appear to diminish the surface tension, as was sometimes stated.

Professor B. P. Haigh's paper on "Slag Inclusions in Relation to Fatigue" stood apart from the others. A vein of slag, he stated, acted like a crack or discontinuity. Slag inclusions were known to promote fatigue; but the influence varied with the method of testing. In the Wöhler test slag particles near the axis had no weakening influence, but particles near the surface reduced the strength. When, however, he submitted the stationary test-piece to direct pull or push by means of alternating-current magnets, slag particles anywhere in the piece were found to accelerate fatigue. The effect might be (1) chemical by making the metal brittle, but the fatigue limit of a brittle solution was commonly higher than that of the ductile solute metal; or (2) expansive, or (3) elastic, because the expansions and elastic constants of slag and metal differed. That the third of these possibilities, implying a concentration of the applied stresses near the boundaries of the inclusion, seemed to be the most important, Professor Haigh showed, by arguments on the lines of his contributions to the British Association Committee on Complex Stresses. As in the case of rivet-holes, ductile metals subjected to stresses which pulsated without changing direction might be comparatively immune from the ill-effects of slag inclusions, provided that the inclusions were small in comparison with the cross-section of the part. Sharp-cornered or lens-shaped inclusions were more dangerous than spherical inclusions. The importance of this research for high-speed machinery was fully recognised by the meeting.

* *Stahl und Eisen*, June 9 and August 3, 1922, pages 1,001–1,013, and 1,192–1,198.

THE BRITISH INDUSTRIES FAIR IN LONDON.

THE London Section of the British Industries Fair, organised by the Department of Overseas Trade, was opened at the White City, Shepherd's Bush, on last Monday, and will remain open until the 9th inst. Fancy goods, electro-plated ware, glass, jewellery, cutlery, &c., are strongly and well represented; stainless steel is used by Messrs. Norton and Gregory, of Westminster, for making their "diamond" drawing instruments. There are altogether about 600 exhibitors, against nearly 800 last year. Whether or not the coincidence of the Fair with the Wembley Exhibition will prove advantageous to the Fair remains to be seen. Novelties do not appear to be conspicuous in the Fair and are certainly not so in the small section for scientific instruments to which we turn. There are many little improvements in the construction of folding eye-glasses to ensure orthocentric and convenient fit. Messrs. W. Gowland, of Croydon, show a new hand perimeter and other ophthalmic instruments. But Messrs. Short and Mason, of Walthamstow, are almost the only makers of barometers, meteorographs, compasses, &c., represented.

The Dixey bevel-edging machine, the invention of Mr. Binhall, manager of the Birmingham works of Messrs. Dixey and Son, deserves description. The machine gives a sharp-edged V-bevel of 45 deg. to lenses of various shapes, circular, oval or square. On the bench two revolving grindstones are so mounted that they turn in parallel vertical planes, the back of the front stone on the left being co-planar with the front of the other stone on the right. The lens to be ground is cut, shanked roughly to shape and centred by a simple device on a horizontal shaft which lies obliquely, at 45 deg., between the two stones, in such a way that each stone grinds one face of the bevel. The "former" which controls the grinding is mounted on to the same shaft, more in front, between a pair of plungers which move to right and left with the grinding stones, when a lever is pulled. These plungers are forced by air pressure against the bevel edge of the former. By means of another indicator lever the distance between the stones can be adjusted to the length axis of the former. An electric motor imparts a rapid rotation of 300 revolutions per min. to the two stones, and also a slow rotation, once in 1½ minutes, to the shaft, which is further traversed from front to back, together with its carrier, at the same rate. This latter motion traverses the piece across the cylindrical rims of the stones, which are thus evenly worn. Other devices keep the edge truly central to the lens thickness. The plungers mentioned prevent any over-grinding of the piece, if it should inadvertently be left in the machine.

Among the new thermometers of Messrs. Powell, of 55, Hatton Garden, are some especially designed for photographers. The thermometers for the dark room are filled with red spirit; on other thermometers there are special marks at 60, 50, 70 deg. F.,

recommended for developing after normal exposure and over- and under-exposure.

The stills and autoclaves of Messrs. Brown and Son, of Wedmore-street, N.19, comprising a combined oven, still and evaporating pan, are more of chemical interest. In the improved autoclaves the lid is, by the internal pressure, pressed against the flange of the autoclave, which is generally made of gunmetal. A perfect seal is thus obtained without the use of nuts and bolts. Autoclaves for high pressures up to 1,000 and even 3,000 atmospheres, are bored out of solid steel bars. The firm also shows a simple gunmetal filter pump for attachment to a water tap. Of other chemical exhibits we notice the rubber substitutes, prepared from vegetable oils, and the rubber pigments, of Messrs. Typke and King, Mitcham Common. The novelties of the Stockton-on-Tees Chemical Works, Limited, whose speciality is barium salt, are their N.P.K. (Pease) fertilisers, the grains of which consist of a base of peat, coke or shale and of ammonium sulphate and potassium sulphate. Large works for the manufacture of these fertilisers are to be erected in Australia.

Electric apparatus is more indirectly represented (in advertising devices and accessories) than directly. The wireless exhibits are not extensive, and do not appear, at the Fair, to be dangerous rivals of pianos, player pianos and gramophones. Various instruments, batteries, variometers, &c. are shown by Messrs. J. J. Eastlick and Sons, of 2, St. Dunstan-hill, E.C., and the new mozzullphone by B.D.S. Wireless, Limited, of Birmingham. This instrument is of the one-valve dual receiver type, the current passing from the antennæ to the tuning coil, valve, crystal detector and in a branch through the condensers back to the valve and receiver.

Another novelty is the "insulac" of Messrs. G. Gilliver and Co., represented by Messrs. Ellis and Sons, of 6, Panyer-alley, E.C. This insulating material, apparently organic, a substitute for ebonite, is moulded in the liquid state and hardens to a uniform mass which can easily be machined and may be immersed in water.

NOTES.

THE BASIC INDUSTRY.

THE largest individual industrial section at the British Empire Exhibition is that covered by shipbuilding, marine, mechanical and general engineering, which comprises the exhibits of more than 400 engineering firms and covers over 5 acres of floor space. It is naturally matter of satisfaction to us that this type of plant should take such a prominent position in the Exhibition, but that position does not more than represent its importance in the industrial world. Practically every trade is at bottom dependent on the work of the engineer, and it is only fitting that his collective exhibit should be individually the most important in the Exhibition. The mechanical engineering exhibits have been organised and brought together by the British Engineers' Association, and the electrical engineering exhibits by the British Electrical and Allied Manufacturing Association, and to signalise the very successful completion of a remarkable piece of work the former Association held a lunch on the 30th ult., at which many speeches were made bearing on the importance of the engineering industry, and the hopes that the Wembley display may do much to cure the present depression through which many of its branches are passing. Engineering is vital with us, and, as Lord Weir pointed out in his speech, although the country might be content to see its ploughmen replaced by shepherds, it could not stand by and see its skilled craftsmen replaced by chauffeurs and garage keepers. The retention of our industrial skill and of our manufactures was vital.

ACCESS TO THE VICTORIA DOCK DISTRICT.

The inadequate means of access to the Victoria Dock district formed the subject of a paper read before the Royal Society of Arts on Wednesday by Sir Henry Maybury. Sir Henry's object in presenting this paper was to draw attention to possible remedial measures to emphasise which, after an historical review of the development of communication with the district in question, he first dealt with the principle obstructions on the main routes to and from the dock area. The first of these obstructions is the bridge over the Lea, built in 1897 by Sir Alexander Binnie, with approaches unsuitable for modern heavy traffic and carrying, according to a census taken in 1922, over 32,000 tons of traffic in 24 hours, mostly from the docks and from the factories in Silvertown, East Ham, &c. Nearer the docks the main road meets with a railway level crossing and a swing bridge at the entrance to the Victoria docks. At the White Gates level-crossing the average daily number of vehicles passing in 1922 was recorded as 2,852, and the gates had to be closed for nine hours and six minutes per day, at the busiest periods of the day being closed for 47 minutes in the hour. Shortly beyond this alternative routes are available, on one of which the road has to negotiate four level-crossings and a swing bridge, while on the other route is a swing bridge, whose 9-ft. carriage way also takes a railway track which is monopolised by wagons for long periods at a time. Further on is another level-crossing. To deal adequately with this situation, Sir Henry Maybury proposes the rebuilding of the Lea River bridge to a road width of 100 ft., the widening of the Beckton Road to 100 ft., and its realignment, and the construction of a raised viaduct about 2,000 yards in length, so as to keep road traffic clear of the railway crossings. In addition, a new swing bridge of 60 ft. width is suggested at the Victoria Dock western outlet. The cost of such a scheme Sir Henry puts at between two and three million pounds, while four or five years would be occupied in bringing it into being. If the new dock planned on the site north of the Victoria and Albert Docks is proceeded with, the present inadequacy of the facilities will become greatly accentuated. Sir Henry urges that the present situation should not be allowed to persist until it becomes impossible to remedy it, and suggests the co-operation of all London, the Home Counties, the Port of London and other bodies in the improvement of means of access to this important area whose trade is of such value to the country.

AIRCRAFT APPRENTICES.—We have received from the Air Ministry a communication calling attention to the fact that, owing to the Government's decision to increase the strength of the Royal Air Force for home-defence purposes, some 700 additional aircraft apprentices are required for entry into the Royal Air Force technical training schools within the next few months. The apprentices are selected from two examinations, one of which is an open examination conducted by the Civil Service Commissioners and the other a limited competition conducted by the Air Ministry in conjunction with local education authorities. The nominal closing date for applications to sit at the next limited competition, which will take place on June 3, is May 6, but applications received during the subsequent week will be accepted. An outline of the scheme and its advantages will be found on page 284 of our issue of August 31 last, but headmasters and others can obtain further particulars on application to the Secretary, Air Ministry, Kingsway, W.C. 2.

THE LATE SIR THOMAS MASON.—The death is announced, from heart failure, of Sir Thomas Mason, D.L., J.P., a prominent citizen of Glasgow, a leading railway constructor and general contractor, and a director of many important engineering concerns. He presided at the annual meetings three weeks ago of Sir William Arrol and Co., Limited, and the Scottish Tube Company, Limited. He died at his home, Craigie Hall, Bellahouston, Glasgow, on Saturday last, in his eightieth year. Sir Thomas was educated in Glasgow and afterwards apprenticed as a mason. When only 18 he undertook a sub-contract which proved to be successful, and thus he early laid the foundations of his business career. Railway construction was then in progress, and he spent many years in carrying out railway contracts. Joined in 1876 by Mr. John Morrison, the firm of Messrs. Morrison and Mason was established and many extensive contracts were obtained. Among their achievements may be mentioned the building of the Carlisle Citadel Station, the Cathcart Railway, the Glasgow Municipal Buildings, the Paisley Canal branch of the Glasgow and South Western Railway, the tunnels and reservoirs at Craigmaddie for the waterworks of Glasgow, the Manchester Corporation waterworks at Thirlmere and 26 miles of aqueducts in connection with them, the Jamaica Bridge, Glasgow, and docks for the British Government. Sir Thomas took a great interest in public affairs and held many public offices in Glasgow. He was knighted in 1909.

LETTERS TO THE EDITOR.

WATERLOO BRIDGE.

TO THE EDITOR OF ENGINEERING.

SIR,—It is with regret we have to recognise the failure of Rennie's great work and to deplore the inevitable removal of one of London's great architectural and engineering landmarks. Fortunately, we are now in possession of sufficient information to enable us to attribute the causes of its failure.

It would appear that the foundations were laid in a layer of ballast overlying the London clay into which piles 20 ft. long were driven (through the ballast). Upon these piles a platform of timber was laid, the spaces between the heads of the piles being filled in with Rubble stone in liquid mortar and well rammed. The piles were of beech and elm 12 in. diameter, whilst the platform was of beech 6 in. thick. We are not informed why the foundations were not carried down into the London clay, but we may fairly assume that the temporary pumping plant of those days was not capable of dealing with the water in the ballast forming the bed of the river and the risk of the cofferdams blowing.

The first error, therefore, was the use of "beech" for the piles and platforms to receive the masonry. In proof of this it may be stated that when the cylinders were sunk for the foundations of Rochester Bridge large quantities of old timber were removed from the bed of the river which had formed portions of the Roman and subsequent ancient bridges. It was of oak, elm and beech, and whilst after the lapse of so many centuries the oak and elm were quite sound the beech was reduced to "pulp." Why beech was used for the foundations of such an important bridge when there was an abundant supply of oak in Surrey and Sussex appears quite inexplicable.

Further, the scour in the channel of the river would be increased by the construction of the Thames Embankment and accentuated by the thick piers of the bridge itself, and so in the course of time the footings and timber foundations became exposed, the timber quickly decayed and settlements ensued. Another point to which attention should be directed is that the upper 15 ft. of the spandrel walls above the arches do not course through the piers, thus causing a straight vertical joint on each side of the piers at the internal angles of the projections. By this defect in the bonding the spandril walls have no tie into the surrounding masonry, and as they have to carry a heavy cornice with its "overhang" and tailing down ballustrade, it is the first portion of the structure to be affected by settlement and excessive vibration, hence the irregularities of the ballustrade and cornice which are now so conspicuous. It should be noted that all the spandrel walls have moved outward, proving that the whole bridge has settled more or less.

The next important point to be considered is the enormous increase of vehicular traffic on the roads (and on this bridge in particular), which is causing serious anxiety to all bridge authorities. Before 1914 the traffic on this bridge was quite negligible whilst the heavy motor traffic at the present time has become dangerous even to the stability of the structure. The depression of Nos. 5 and 6 arches under the traffic are at times visible.

It is beyond doubt that the increased traffic has accentuated the vibration on the foundations and given the *coup de grace* to the already unstable structure.

It is now quite obvious that the bridge must be rebuilt (it does not require an expert to see when a bridge is falling down), and it is interesting to raise various points for consideration in connection with its reconstruction.

It would be very unwise to rebuild the piers upon their present foundations owing to the mass of decayed timber in the bed of the river under them. If rebuilt on the same site the new foundations should be located between the present piers. Hence the necessity of having a bridge of different spans to the existing one, *i.e.*, one of a different design to Rennie's though of a similar character.

The suggestion of the P.L.A. for a bridge of three spans is only applicable with steel spans—a bridge of three spans in masonry would be too heavy for the foundations in such soft ground as the bed of the River Thames (the risk of settlement would be too great).

The nearest design to Rennie's would be one of masonry of about six spans (semi-elliptical in shape), of granite, similar in character, of which there would be no difficulty in producing an equally good design.

Assuming the bridge has to be widened 30 ft. and built on the present site, there would be no insuperable difficulty in building it one half (longitudinally) at a time on new foundations between the existing piers; the new widening being built first and the old bridge

being subsequently removed and the remaining portion built, the present piers being used as staging for the new work.

A similar procedure was adopted by us at Rochester Bridge in 1911-14, when the new bridge was built above the old one which was used as a staging and subsequently removed from beneath. By doing this one half at a time and turning the traffic over the completed portion, the expense of a temporary bridge was saved. In this case the same procedure is quite practicable, and would in my opinion be a quicker and more economic scheme of reconstruction. The outline of the procedure would be briefly as follows :—

A temporary bridge would not be required inasmuch as the present structure would be utilised for that purpose in the following manner. All the top weight of masonry down to the bed of the frieze, including the roadway and footpaths, would be at once removed and a temporary roadway of lighter material substituted for vehicular traffic, with a timber footpath for pedestrians constructed on the downstream side. This could be done in about three months and several thousand tons of dead load taken off the foundations without stopping the traffic. Further, in cases of unstable foundations, experience has been that the removal of top-weight has materially reduced the vibration on the structure. The widening of the bridge would be constructed separately on the upstream side, the piers of which would come between the present piers.

On the completion of this portion the traffic would be turned over it and the present bridge demolished down to the springing of the arches, the old piers being used to carry the centreing and staging for the new bridge.

The new bridge as widened would really be constructed in two separate portions (longitudinally) to prevent unequal settlement. The advantages of this scheme of procedure would be the saving in time and cost of a temporary timber bridge and a saving of probably 30 per cent. on the cost of the centreing and staging for the arches of the old portion (not the widening).

The advantage of this would be "immediate," because of the urgency of relieving the foundations of all superfluous weight. If the bridge is allowed to remain in its present state under the present conditions, who can guarantee that it will stand during the eighteen months required to build the temporary bridge (the probabilities are against it). The three months occupied in carrying out this temporary work could be occupied in preparing plans for the new bridge and arranging the contract.

In conclusion, I would say that procedure of this nature was found to work out very successfully at the rebuilding of Rochester Bridge, which was carried out without any mishap or delay to the tramways, telegraphs, telephones, and other wayleaves; nor was the traffic ever stopped during the whole period of reconstruction.

I remain, Sir, Your obedient Servant,

JOHN J. ROBSON, M.Inst.C.E.

Gravesend, April 18, 1924.

"THE COMPARISON OF INTERNAL-COMBUSTION ENGINE EFFICIENCIES."

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the leading article in the issue of ENGINEERING, of April 11, in the course of which the kilogram-molecule or pound-molecule (later referred to as mol) is commended as a unit quantity of gas in internal-combustion engine calculations, the case is not so simple as was stated, and there is something to be said on the other side. Indeed, when the pros and cons are weighed the advantage, to say the least, is very doubtful.

The convenience of the constancy of R for one mol of any gas is upset by the change in the number of molecules of the charge which accompanies combustion. If combustion is complete, this change may be a reduction of anything up to about 8 per cent. in the case of common industrial gaseous fuels and an increase up to about the same figure in the case of petrol and other like easily vaporised fuels. The mass of the charge, however, in these cases is constant and as engineers in this country are accustomed to deal with unit mass in other thermo-dynamic calculations, the introduction of the kilogram-molecule or pound-molecule on the score of the constancy of R is likely to lead to confusion of thought without offering an advantage.

Another ground upon which the mol is recommended, is that the molecular heat capacity of diatomic gases is approximately the same. It is not safe, however, to assume that because volumetrically nitrogen is a preponderating constituent of the working fluid, it dominates the heat capacity to anything like the same extent. If this were so air might well be taken as adequately representative of the actual working fluid but, generally, this it does not do, because of the heat capacity of the triatomic molecules CO_2 and H_2O present in the products of combustion. An examination of the most reliable data upon the specific heats of gases at high temperatures and interpolation in expressions based thereon (see later) shows that at 500 deg. C. (abs) and 2,000 deg. C. (abs) N_2 (taken to include air) CO_2 and H_2O have the following molecular heats :

Molecular Heat per Degree Cent. at Constant Volume.

N_2.		CO_2.		H_2O.	
500 deg.	2,000 deg.	500 deg.	2,000 deg.	500 deg.	2,000 deg.
5·06	6·43	7·87	11·94	6·76	10·71

Taking a case where the burnt gases consist of 75 per cent., $N_2 + O_2$, 14 per cent. H_2O and 11 per cent. CO_2 the heat capacities of equal volumes of the gas and air are in the ratios :—

	500 deg.	2,000 deg.
$\frac{\text{Heat capacity of gas}}{\text{Heat capacity of } N_2 \text{ or air}}$	1·11	1·19

Here it is seen that the heat capacity of the actual working fluid after combustion is nearly 20 per cent. higher at 2,000 deg. than that of the diatomic gases and 11 per cent. higher at 500 deg. C. Obviously, the molecular heat of a diatomic gas does not sufficiently well represent the actual working fluid. It remains to inquire whether the molecular heat capacity of the actual gases suffers a greater or less change than the heat capacity of unit mass as a result of combustion.

Considering producer and blast furnace gases the combustible constituents may be regarded as chiefly H_2 and CO. As whatever change takes place is due to the combustion of these two gases, it is only necessary to ascertain what happens when each is burnt with the required amount of O_2. The data given below have been calculated for combustion of each gas with the theoretical quantity of air for complete combustion on the basis of the following molecular heat capacities :—

Gas.	Heat Capacity per Mol per Degree C.
&	
N_2O_2	$C_v = 4\cdot86 + 0\cdot284 \times 10^{-3}T + 0\cdot25 \times 10^{-6}T^2$
CO_2	$= 4\cdot56 + 7\cdot59 \times 10^{-3}T - 1\cdot95 \times 10^{-6}T^2$
H_2O	$= 7\cdot51 - 2\cdot54 \times 10^{-3}T + 2\cdot07 \times 10^{-6}T^2$

R for one mol $= 1\cdot987 = C_p - C_v$

T = temperature deg. C. (abs).

Let E = internal heat energy and I = total heat energy.

It is common to integrate equations for C_v and C_p to obtain E and I and to take these as zero when T is made zero in the resulting equations. If I may digress a little, the values of E and I so obtained have no definite physical meaning since the expression for C_v and C_p do not hold down to T = 0. It is more satisfactory therefore, to choose a datum where the relations for C_v and C_p are more valid and in what follows E and I represent energies above T = 273 deg. or 0 deg. C. In any case, heat engine calculations are based upon differences of E and I and 273 deg. is a low enough datum for most practical purposes.

Combustion of CO *and* H_2 *with Theoretical Air.*

Reduction in number of molecules due to combustion = 14·7 per cent. in each case.

Fuel.	Energy above 0 deg. C.	*	T = 300 deg.	T = 500 deg.	T = 1,000 deg.	T = 2,000 deg.
CO.	E for unit mass ..	B.	4·7	39·76	131·0	336·1
		A.	4·42	39·98	136·9	368·9
	E for one mol. ..	B.	135	1,137	3,743	9,600
		A.	148	1,306	4,591	12,380
	I for unit mass ..	B.	6·56	55·53	181·5	456·1
		A.	6·02	52·43	179·9	471·2
	I for one mol. ..	B.	188	1,590	5,185	13,040
		A.	201	1,759	6,029	15,800
H_2	E for unit mass ..	B.	6·41	54·4	179·2	459·8
		A.	6·19	52·26	170·0	447·1
	E for one mol. ..	B.	133·9	1,136	3,746	9,620
		A.	151·6	1,281	4,163	10,940
	I for unit mass ..	B.	8·97	76·0	248·4	624·2
		A.	8·38	70·67	229·0	587·2
	I for one mol. ..	B.	187·3	1,587	5,190	12,030
		A.	205·3	1,731	5,613	14,390

* B in this column denotes gas before combustion, and A indicates gas after consumption.

The foregoing figures show that in the case of CO heat energies E and I per unit mass suffer considerably less change due to combustion than do the same quantities per mol, and in the case of H_2 the advantage is slightly in favour of the unit mass. On the whole, therefore, the preceding seems to indicate that in gaseous fuels whose combustible constituents are chiefly H_2 and CO there is greater equality in the heat capacity before and after combustion of unit mass than for one mol.

Other cases, I think, would similarly fail to show an advantage in favour of the kilogram-molecule or pound-molecule on the score of constancy of heat capacity.

Sufficient has been said to indicate that the diatomic gases do not provide an adequate representative working fluid. The problem is to select a hypothetical working fluid which as closely as possible represents the actual products of combustion or, in other words, to choose a suitable mixture of diatomic gases, CO_2 and H_2O, and Prof. Stodola's expression for specific heat as employed by Mr. Wells is equivalent to this. Also for convenience in working it is usual to neglect the alteration by combustion in the number of molecules present and a mean molecular weight needs to be chosen, which, of course, is equivalent to fixing an average gas constant, as is done by Mr. Wells. Thus, the steps which have to be taken to approximate to the actual working fluid really destroy the scientific basis advanced in favour of the kilogram-molecule and pound-molecule, and reduce it to a unit mass basis. Why, therefore, depart from the pound mass as the unit of quantity ?

I am, Sir, yours faithfully,

R. W. BAILEY.

23, Stockport-road, Altrincham, Manchester.

April, 22, 1924.

"AIR CONSUMPTION AND POWER OF PETROL ENGINES."

TO THE EDITOR OF ENGINEERING.

Sir,—In the discussion of Dr. Moss's paper on "Air Consumption and Power of Petrol Engines" which was reported in your issue of April 18, 1924, Mr. William Reavell urged that nozzles were both more accurate and more easily worked with than orifices. In this connection I think that the following facts, which are not generally known and appreciated, will be of interest to your readers.

(1) It is impossible to make nozzles which have constant coefficients of discharge over the range of flows usually worked with (*i.e.*, for values of $QW/d_2\mu$ between, say, 50 and 1500). The coefficient of discharge of nozzles varies from about 0·93 at low working flows to about 0·99 at high flows in a similar manner to that shown for Venturi tubes in Fig. 1, page 440, of your issue of April 4.

Nozzles whose contours have abrupt changes in the radius of curvature, either due to the method of setting out, or to faults in machining have usually lower and less regular coefficients of discharge than those with smooth contours. Even when great care is taken with the machining, it is found extremely difficult to produce nozzles whose coefficients of discharge agree to within 2 per cent. or 3 per cent. The writer has found that at the flows usually worked with, the coefficient of discharge, even for well formed nozzles, is nearer to 0·96 than 0·99.

(2) Square edged orifices, on the other hand, are perfectly easy to reproduce with such accuracy that their coefficients of discharge can be relied upon to within *one quarter of one per cent.* They are also much cheaper to make than is the parabolic nozzle.

A reference to Figs. 3B and 3C, on page 314, of your issue of March 7, will show that the coefficient of discharge of the square-edged orifice is (unlike that of the nozzle) constant over a flow range which *exceeds one to a hundred.* The formula used for any one orifice is no more complicated than that used for a nozzle and may, in certain cases, actually be simpler (see Hodgson, Proc. I.C.E., Vol. cciv, Part II, page 185, equation 55).

From every point of view the square edged orifice would therefore seem to be preferable to the shaped nozzle.

Yours faithfully,

JOHN L. HODGSON, M.I.Mech.E.

Eggington House, near Leighton Buzzard, Beds.

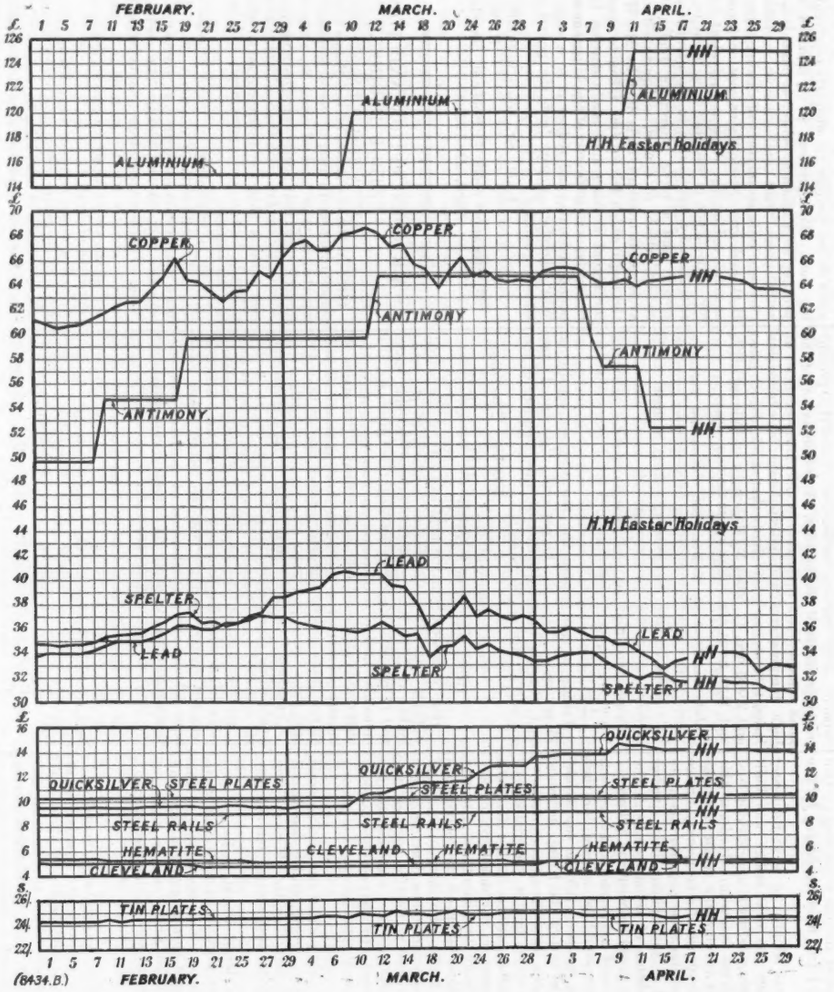
April 28, 1924.

THE DEMOLITION OF PARIS FORTIFICATIONS.—We take the following figures from *La Science Moderne*, Paris. Of the 95 bastions in the old fortification wall, surrounding the French metropolis, 20 were completely levelled in July, 1923, and 10 others were in course of demolition. The 45 kilometres (28 miles) of wall encircling Paris contain 800,000 cub. metres (28 million cub. ft.) of masonry, and 6,000,000 cub. metres (212 million cub. ft.) of earth. The material forming the masonry portion is gradually being used for house-building throughout the country.

FOOD STUFFS AND RAW MATERIALS AT THE EXHIBITION.—As the principal exhibits of foodstuffs and raw materials in the British Empire Exhibition are being shown by the members of the British Empire Producers' Organisation, and as those exhibits are widely scattered and of immense variety, the Organisation has undertaken to classify all such exhibits and to give information concerning them. Every visitor, therefore, who wishes to undertake a comprehensive study of any Empire food stuffs and raw materials should pay a preliminary visit to the British Empire Producers' Bureau in the British Guiana Section, where all information and a guide card are given, free of any charge.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN THE PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal and Scotch Pig-Iron Warrant Markets.)



METAL PRICE DIAGRAMS.

NOTE.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given in the case of steel plates and for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of quicksilver is per bottle, the contents of which vary from 70 lbs. to 80 lbs. The price of tin-plates is per box of I.C. cokes f.o.b. at Welsh ports, but in all other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each.

CANADIAN CAPACITY MEASUREMENTS.—In Canada technical newspapers and books frequently refer to the capacity of tanks, pumps, pipe lines, &c. At times there is confusion between the Imperial and U.S. measure. Before using data mentioning the gallon, unless Imperial or U.S. gallons are specifically stated, the origin of the article should be ascertained, says *Canadian Machinery*, since the Imperial gallon contains approximately one-fifth more than the U.S. one. In Canada, the Imperial gallon is the standard.

CLEANING APPARATUS FOR WATER MAINS AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. GLENFIELD AND KENNEDY, LIMITED, ENGINEERS, KILMARNOCK.

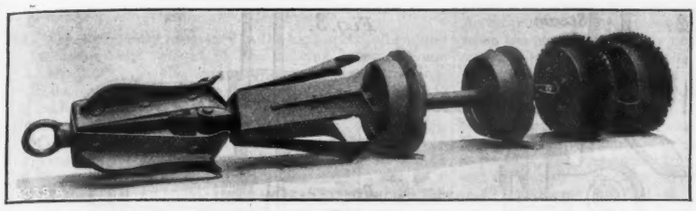


FIG. 1.

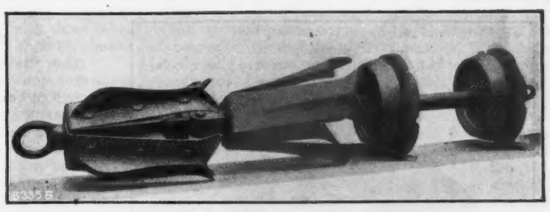


FIG. 2.

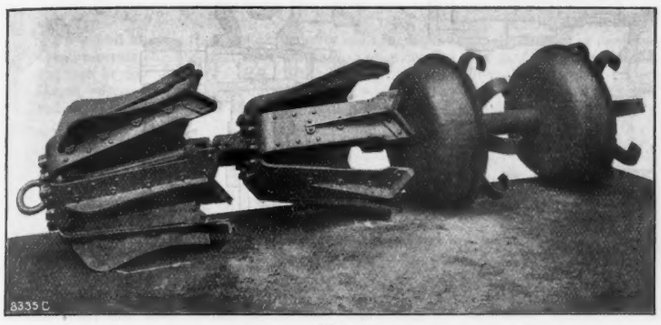


FIG. 3.

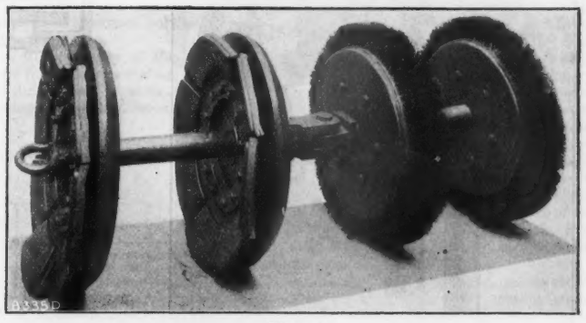


FIG. 4.

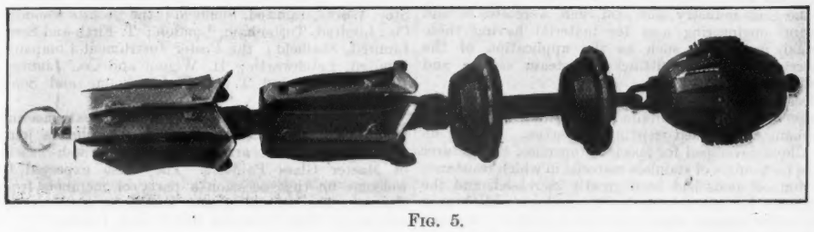


FIG. 5.

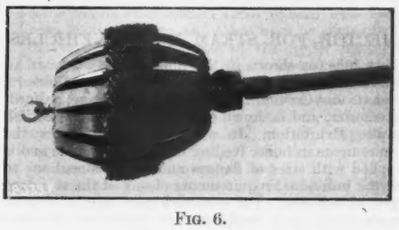


FIG. 6.

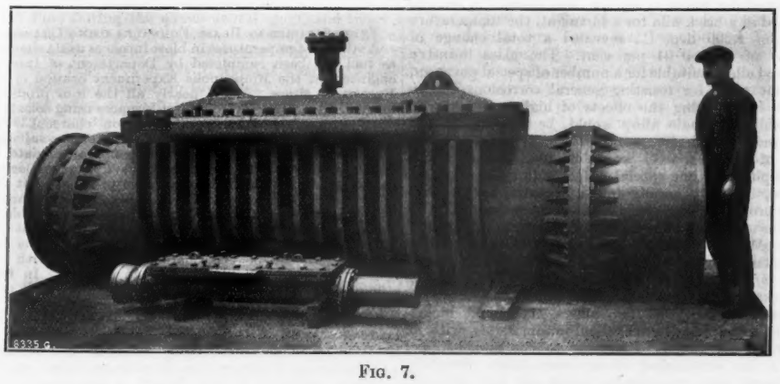


FIG. 7.

CLEANING APPARATUS FOR WATER-MAINS.

As all water-works engineers are aware, trouble is not uncommonly experienced from the fouling of water-mains, and when this occurs it is only a matter of time until steps have to be taken to deal with the matter. The trouble may take different forms; in some countries, where at certain seasons of the year much silt is carried in suspension, the mains may become so choked that periodical cleanings are necessary; in other circumstances hard nodular incrustations of crenothrix, or slimy algoid deposits, equally demand attention. The general method of cleaning mains is to insert in them a "go-devil" which is propelled through them by the pressure of water behind it and scrapes off, in its passage, the deposit from the walls. The exact design of the apparatus depends, of course, largely upon the particular nature of the work to be done, but the "go-devil" in general consists of two or three short lengths of iron rod, jointed together to give flexibility, the front lengths being furnished with scraping or brushing heads, followed by some form of piston for the water pressure to act on. It is usual for the piston to contain orifices, the size of which is often made adjustable, so that there is always a flow of water through the apparatus while it is travelling along a pipe. This sweeps away the debris loosened by the scraping head and prevents the machine being blocked by the results of its work. A properly designed "go-devil" will travel very long distances underground by itself, and will pass round bends and through gate-valves without difficulty. It usually goes along at a slow walking pace, and can be followed by its sound even when the pipes are quite deeply buried.

Figs. 1 to 5 annexed illustrate several types of the apparatus in question, suitable for different duties, shown at the British Empire Exhibition by Messrs. Glenfield and Kennedy, Limited, of Kilmarnock. Fig. 6 illustrates a spring brush, operated by hand by means of a long length of iron pipe attached to it. To get the cleaning apparatus into and out of water-mains it is clear that the mains must either be cut, or some other provision must be made. It is an expensive job cutting pipes and making good again afterwards, so that when the necessity for periodical cleaning is foreseen it is often the custom to put hatch-boxes at certain places along the mains, so that access may be had to the interior of the pipe. Fig. 7 shows two such hatch-boxes, made by Messrs. Glenfield and Kennedy, Limited, one for a 6-in. pipe and the other for a 36-in. pipe. The design is similar in each case, the removal of the flat bolted cover allowing the cleaning apparatus to be inserted or withdrawn.

REPORT OF THE AIR SURVEY COMMITTEE.—In the autumn of 1920, the War Office invited the Air Ministry and the Ordnance Survey Department to collaborate in forming a small permanent Committee to deal with the compilation of war maps largely, or in part, from photographs taken from the air. This committee, known as the "Air Survey Committee," was duly formed and its constitution and functions decided upon after a preliminary meeting in November, 1920. Its functions are the initiation of research in apparatus and methods used, the maintenance of a record of information, and the interchange of information with any scientific departments that may be interested in the subject. The first report of the committee, which has just been issued and is obtainable from any of the branches of H.M. Stationery Office, price 4*s.* 6*d.* net, covers the progress of the subject up to 1920, deals with the developments undertaken by the committee and with its achievements in detail. Methods other than those employed by the committee are reviewed, and a number of appendices are attached to the report defining the terms used, containing notices of books, dealing with the costs of the work, giving a short bibliography of the subject, &c. The report is fully illustrated and the matter is clearly written, so that it forms a very useful contribution to the literature of the subject of aerial surveying.

INJECTOR FOR STEAM MOTOR VEHICLES AT THE BRITISH EMPIRE EXHIBITION.

CONSTRUCTED BY MESSRS. GRESHAM AND CRAVEN, LIMITED, ENGINEERS, MANCHESTER.

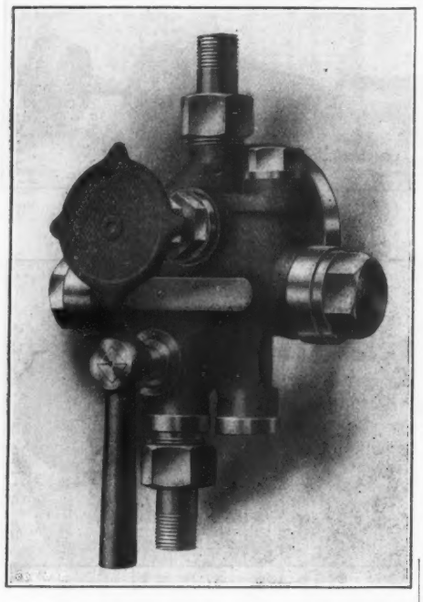
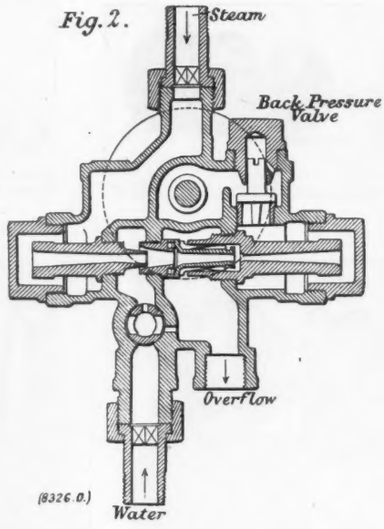
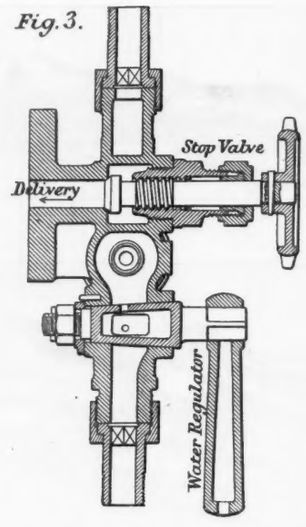


Fig. 1. Horizontal Combination Injector.





INJECTOR FOR STEAM MOTOR VEHICLES.

The injector shown in the illustrations above is an important item in the range of manufactures of Messrs. Gresham and Craven, Limited, of Ordsall Lane, Salford, Manchester, and is shown on their stand in the British Empire Exhibition. It was designed to meet the requirements in boiler feeding for steam wagons, and is supplied with sizes of flanges and pipe connections to suit the individual requirements of any of the standard types of vehicles. The essential parts are, of course, standardised, and replacements may be obtained immediately by the use of the index number system of the makers. The passages for steam and water through the nozzles and cones can be clearly seen from the sections Figs. 2 and 3. The cones are four in number, serving the distinctive purposes of admitting steam, lifting water, combining and delivery. It should be noted that the combining cone, the third in the system, can move in its seating and take up a position depending on the pressure conditions inside. When actually delivering feed water, the lifting cone and the combining cone are held together as though they were one. The velocity attained on emergence from the delivery nozzle is great enough to ensure the lifting of the back pressure valve and the passage of water into the boiler. These injectors are in very general use, which is a good index of their reliability and suitability for their purpose.

SOCIETY OF GLASS TECHNOLOGY.

The seventh annual general meeting of the society was held in Sheffield on Wednesday, April 16, 1924, the President, Professor W. E. S. Turner, D.Sc., in the chair. Colonel S. C. Halse, C.M.G. (Messrs. J. Lumb and Co., Limited, Castleford), was elected President in succession to Professor W. E. S. Turner. The other vacancies arising were filled as follows: Vice-Presidents, F. G. Clark (Messrs. Beatson, Clark and Co., Limited, Rotherham), R. L. Frink (Glass Research Association, London). Members of Council, H. A. Bateson, W. R. Dale, J. Moncrieff, W. J. Rees, B.Sc.Tech., F.I.C., J. H. Steele, J.P., and H. Webb. Honorary Treasurer, J. Connolly. American Treasurer, Wm. M. Clark, Ph.B. Honorary Secretary, S. English, M.Sc. Auditors, E. Meigh, M.Sc., Dennis Wood, F.S.A.A.

The annual report and accounts for 1923 showed that year to have been a successful one. The foreign membership continued to increase, numbering 190 out of 615 at the end of 1923. Of these 109 were resident in the United States. Altogether the society was connected by membership with no fewer than 17 countries. Professor Henry Le Chatelier, Paris, was elected an honorary member of the society.

A paper entitled "*The Physical Properties of Some Alloys Resistant to Heat and Corrosion*" was read by J. H. G. Monypenny, F.Inst.P., and illustrated by lantern slides and specimens. The author dealt with problems which might occur in machinery pertaining to the glass industry, and said there were also certain general engineering uses for material having these special properties, such as the application of the material to various fittings for steam service and hydraulic work.

Dealing first with stainless steel he outlined the range of properties obtainable, dwelling also on the mechanical and heat-resisting properties. Passing on to alloys developed for special properties, the lecturer gave particulars of stainless material in which resistance to mineral acids had been greatly increased, and the tendency for galvanic action in contact with bronze and other copper alloys entirely removed. A short description of some special alloys which had been developed for resisting scaling was given. A sample exposed in a brick kiln for a fortnight, the temperature reaching 1,200 deg. C., revealed a total change in weight of only 0·04 per cent. The glass industry required alloys suitable for a number of special purposes, in some cases for resisting general corrosion, and in others for resisting the effects of high temperatures. Probably no single alloy would be suitable for all purposes, though for many of those purposes some type of stainless steel would be found useful. For developing any one special property in an exceptional degree, it was generally found necessary to sacrifice other properties to some extent, so that it was advisable for the maker and the user to collaborate.

Mr. W. R. Barclay, A.M.I.E.E., followed with a paper entitled "*Some Properties and Possible Industrial Uses of Alloys containing Nickel.*" Illustrating his remarks with lantern slides, Mr. Barclay said that he proposed to deal with two alloys, the simple nickel-copper series and the nickel-chromium series, with no other metals added. Referring to the nickel-copper alloys he emphasised their remarkable ductility, combined with considerable toughness and strength, and very considerable resistance to corrosion. A retention of strength at temperatures higher than those at which ordinary non-ferrous metals broke down was particularly evident in the nickel-copper alloys containing high nickel. As an illustration of the enormous ductility, he quoted a recent example of material manufactured, in which it had been possible to cold-work a 2-in. bar right down to 0·02 in. without annealing.

Proceeding to deal with the nickel-chromium alloys, he pointed out that the two hitherto developed were the 85 per cent. nickel, 15 per cent. chromium, and the 80 per cent. nickel, 20 per cent. chromium. They were remarkable materials, bridging the great gulf that had hitherto existed between ferrous and non-ferrous materials, and combining in a high degree the best properties of both. These were the alloys which had made modern developments of electric heating possible. A very important application of them, which the immediate future would see unquestionably, was their use in annealing furnaces.

During the morning an exhibition of special steel and non-ferrous alloys, and of tools and plant made from them, was held in the Department of Glass Technology of the University of Sheffield. The following firms exhibited: Messrs. Brown, Bayley's Steel Works, Limited, Sheffield; the Cronite Foundry Co., Limited, Tottenham, London; T. Firth and Sons, Limited, Sheffield; the Foster Instrument Company, Limited, Letchworth; H. Wiggin and Co., Limited, Birmingham; and T. G. Wolstenholme and Sons, Sheffield.

The President announced that the next meeting would be held in London on May 27, when a joint conference had been arranged with the British Society of Master Glass Painters. They also expected to welcome on that occasion a party of members from France. The annual dinner would be held on the evening of May 27 in the Hotel Cecil, London.

Temperatures in Blast Furnaces using Charcoal.—A study of temperatures in blast furnaces using charcoal as fuel has been completed by Department of Interior engineers at the Minneapolis Experiment Station of the Bureau of Mines. While nearly all the iron produced in the United States is from blast furnaces using coke fuel, some furnaces are being operated on charcoal. The charcoal iron is usually manufactured for special uses, as in parts of automobiles. The temperature data on smelting charcoal iron were needed chiefly for comparison in the general study of blast-furnace problems. It was found that the temperatures under which charcoal furnaces are operated are lower than is permissible in coke practice. Furthermore, it was learned that the principal factor in causing this difference is the low sulphur content of the charcoal compared with the higher quantity of sulphur present in coke. In fact, the effect of sulphur in the blast-furnace charge is even more important than was hitherto believed.

German Technical High Schools in Winter, 1923–24.—Last winter the attendance totals at the German technical schools showed a decrease, for the first time since the war. This decrease affected all the technical branches with the exception of mining and general science. The figures remained much higher, however, than those for the winter 1913–14. The total numbers of students at the 13 German technical high schools for the winters 1923–24, 1922–23 and 1913–14 were 27,573, 28,482 and 11,726; to these figures have to be added, in all the three cases, about 5,000 "hearers" and "guests," not on the academic lists. The numbers include the technical high school at Danzig, which had, in the three winters mentioned, 1,634, 1,947 and 1,329 students. The numbers of students of engineering and electro-technics amounted to 13,950, 14,357 and 4,304 during the same periods. München, with 5,262 students of all classes, is still the most popular technical high school, and has not been greatly affected by the decrease; Berlin comes next with 4,768 students last winter against 5,218 in the previous year; Dresden, which last winter occupied the third place with 4,062 students, had alone increased its attendance. One feature must not be overlooked in these statistics—if the means at the disposal of these institutions have diminished of late years, the professors' salaries and students' fees have also decreased.

FURTHER EXPERIMENTAL WORK ON DIESEL ENGINES.*

By Engineer-Commander R. BEEMAN, C.M.G., R.N., Engineer-in-Chief's Department, Admiralty.

(*Continued from page 559.*)

EXPERIMENTAL WORK.

Aluminium Alloy Pistons.

IT is evidently necessary in the high-speed oil engines to reduce the weight of the moving parts. Some saving may be effected in such items as connecting-rods and crank-shafts by careful design and high-grade material, but it is in the piston that the greatest scope exists for economy. These pistons, when of the trunk type, are designed with a number of considerations in view, viz., to act as a support of the gudgeon-pin, to provide the required thrust surface, and to act as a ring carrier. In general practice cast iron has been the material employed for these parts, but with the research work carried out in recent years aluminium alloys have been developed which have in some cases even better physical properties for the purpose in view than cast iron.

As is well known, they are universally used for high-speed aircraft engines, and they are finding an increasing use in motor-car practice. Their employment in larger engines is a logical outcome of the efforts to reduce the inertia effects attending high piston speed.

TABLE II.

Designation of Engine.	Type.	R.P.M.	Cylinder Diameter, Inches.	Stroke, Inches.	Mean Piston Speed, Feet per Minute.	Piston.	
						If cooled.	Description.
Unit	4-cycle S.A. solid injection.	380	14½	15	950	No.	Piston in two portions divided at gudgeon-pin axis, studs in top half.
Digit	4-cycle S.A. air injection.	390	20	20	1,300	Yes.	As above, but two portions connected by bolts.
Opposed-piston Doxford type.*	2-cycle S.A. air injection.	360	14·35	28·34 (combined)	850	Yes.	Each piston in one piece.
Stepped piston†	2-cycle S.A. air injection.	390	18	20	1,300	Yes.	Piston in one piece.
"H" Class	4-cycle S.A. air injection.	375	9	12	750	No.	Piston in three portions; head and skirt of aluminium alloy, distance piece of cast-steel.

* This engine is also fitted with an aluminium alloy scavenge piston.
† This engine is fitted with a 25¼-in. aluminium alloy supercharge trunk piston, which carries the gudgeon-pin on the power line. It is connected to the power piston by a steel distance piece.

The production of large pistons in aluminium alloy has not been without difficulties, but these have been surmounted and all the experimental engines are so fitted.

A number of minor difficulties have arisen from time to time during the experimental work, and these are gradually being eliminated by variations in design and manufacture, and the experience with them at the present time is sufficient to warrant their employment as occasion demands in the Fleet.

The alloy adopted for such pistons for the Naval service has the following approximate composition :—

	Per cent.
Copper	3·0
Nickel	1·5
Magnesium	0·5
Iron	0·5
Silicon	0·5
Aluminium	93·5

With suitable precautions in the design and founding of large pistons (up to 25 in. diameter), combined with subsequent heat treatment, tensile tests have shown results of 12 tons per sq. in. with elongation on a B.S. test piece, 2 in. long, of 3 to 4 per cent. In the particular case of a large piston over 20 in. diameter recently manufactured, a tensile strength of 20 tons was obtained, the casting being sound throughout and free from any deleterious effects of the heavy shrinkage which is a feature of cast aluminium alloy work.

The experience obtained with these alloy pistons will be considered in a little detail. Table II shows particulars of the experimental engines in which they have been fitted.

The saving in weight of the reciprocating parts achieved in the Unit engine and the effect on the inertia forces were given in the 1920 paper. The piston of this engine was subjected in its early days to severe loading (up to 150 lb. per sq. in. mean pressure) and found generally satisfactory. It has been in use since that time until quite recently, and has proved to be generally suitable for continuous service. The engine has been in regular use for experimental purposes running at or about the nominal load (100 lb. per sq. in.). Such defects or failings as it has developed during the period are not attributable to unsuitability of the material, but are rather due to weaknesses in the structural design which further experience has remedied.

This piston was recently removed to give way to an alternative design and was then carefully measured. A comparison of these measurements with those taken when the piston was nearly new early in 1917, showed no sensible indications of either growth or wear.

The high coefficient of expansion of aluminium alloys entails special precautions in design and in fitting, and the working clearances found necessary are at least 50 per cent. in excess of those required for cast iron. Naturally the tendency is to run the clearance as fine as possible, but it is known from laboratory experience, and with other engines on service, that the adoption of small clearances has led to their absorption under working conditions and seizure of the pistons. These seizures have incidentally demonstrated one possible advantage of aluminium pistons in so far as the damage has been confined to the piston itself, which under such conditions rapidly overheats and becomes soft and the liner is in most cases not even scored.

It may be expected also from this property of the alloy that if other materials are fitted in association with the piston some effects of differential expansion would be observed. The slackening of the steel studs screwed into the top portion of the piston for attachment of the lower portion has been experienced. This was attributed originally to relative expansion effects, but it has since been demonstrated that this is not the correct explanation and that actually the threads in the aluminium alloy yield. This effect can be minimised with care, but it has been judged desirable in larger pistons to provide for an alternative attachment with bolts and nuts.

The gudgeon-pin bushes are gripped between the two portions of the piston, and to anticipate differential expansion it has been usual to arrange that when the two portions are secured together (with the gudgeon-pin bushes removed) the vertical diameter of the recesses should be about 0·005 in. smaller than the bush diameter. Thus, with the bushes fitted in place and the two piston halves abutting a compressive stress is set up in piston and bushes. Under heated conditions it is estimated that the bushes should then never be slack in the piston. It has been found, notwithstanding, in this particular engine and in similar engines on service that a peculiar type of hammering action takes place on the outer surface of the bushes in the regions under load which leads to distinct depressions there, but no sign of the action is discernible on the adjacent portions of the aluminium piston itself.

Signs of the action of the bushes, although to a lesser degree, have also been observed in the Digit engine but, although an attempt has been made to reproduce the action in a special bearing testing machine it has not been found possible to do so and its exact cause remains obscure.

Meantime the defect has been remedied as required by an alternative material for the bushes, and in another case by an alternative design of bush having square backs.

The aluminium alloy portions of the piston constituting the ring-carrying portion have proved satisfactory and, beyond an increase in width of about 0·004 in. in the groove for the upper piston ring after long service, no appreciable wear has been observed. Special attention was given to the ring design. The rings are made ¼ in. wide, measured in the direction of the stroke and, in order to obtain the maximum bearing surface on the piston, as thick radially as is possible, consistent with attaining the necessary flexibility for assembly.

The Digit piston, which is oil-cooled, shows no appreciable wear or distortion. The slight differences in its construction compared with that in the Unit engine and the fact that it is oil-cooled have eliminated the defects experienced with the early design.

This engine has had a considerable amount of running at high load, and the experience both with the design and material of the piston has been entirely satisfactory.

The opposed piston engine of the Doxford type has, of course, a different design of pistons, these being merely ring carriers which are attached to the external cross-heads by means of steel rods. As originally constructed this engine was fitted with pistons of cast iron, but in conformity with experiments carried out in the other experimental engines it was decided that pistons of aluminium alloy should be fitted to determine their suitability in an engine of this type where, in the absence of a cylinder cover and also due to the fact that the engine works on the two-cycle principle, more severe conditions in the way of heat stresses may be expected, as compared with a 4-cycle engine, other things being equal.

Before proceeding with the trial of pistons of "all" aluminium alloy it was decided to try aluminium pistons fitted with steel crowns partially cooled. Such pistons are generally referred to as "incandescent" pistons. The design proved generally satisfactory, but it was found, as might be expected, that the steel crowns showed a certain amount of wastage due to burning or erosion, especially in the case of the upper piston. Since the scavenge air enters at ports which are uncovered by the lower piston at the bottom of its stroke, whilst exhaust takes place through ports uncovered by the upper piston at the top of its stroke, the plate on the lower piston reaps most of the benefit obtained from the cooling effect, of the inlet scavenge air, and a higher average temperature would therefore be expected at the upper piston.

These "incandescent" pistons have subsequently been replaced by all aluminium alloy pistons which have now been on service 18 months. The engine has been in regular use to supplement the electrical power requirements of the Laboratory, its average load being from 140 to 160 lb. mean pressure at 300 r.p.m. At a recent examination these pistons were found in very good condition and there were no signs of erosion or burning. In the case of the upper piston alone has any irregularity been observed, and that was some slackening of the studs screwed into the aluminium alloy for the attachment of the piston rod.

The behaviour of the alloy pistons in both the power and supercharging cylinders of the stepped-piston engine has been satisfactory, but this engine has not yet been subjected to its full load.

Due to the high heat conductivity of these aluminium alloy pistons combined with the special attention given to other parts to secure efficient cooling under load, it has been found necessary to work to comparatively high compression pressures to obtain easy starting. The compression pressures obtained under load in the experimental engines are of the following order :—

Unit engine (solid injection)	380 lb.
Digit engine (air injection)	495 lb.
Doxford engine (air injection)	510–515 lb.
Stepped piston (air injection) .... not less than	520 lb.
"H" Class piston (air injection)	490 lb.

For comparison with these figures, as illustrating the precise effect of the alloy pistons, it may be stated that in the case of the Doxford engine, 460 lb. was worked to with cast-iron pistons and 490 lb. with the "incandescent" pistons.

DEVELOPMENT OF HIGH MEAN PRESSURES.

The high speed of revolution shown to be necessary in the Naval engine makes the successful attainment of high mean pressures in the cylinders more difficult owing to the lesser time for the operations of fuel injection and combustion and for heat flow.

The expression, "mean pressure," referred to here and elsewhere in this paper signifies the mean indicated pressure.

It is proposed to consider some of the problems intimately connected with the attainment of high mean pressures and to describe some of the work carried out in attempting to arrive at their solution. These problems may be grouped conveniently as follows. Those associated with :—

(1) The successful injection, at the high speed of operation, of the large quantity of fuel required per cycle.

(2) The determination of a suitable profile for the fuel cam actuating the sprayer.

(3) The shaping of the combustion space.

(4) The high rate of heat flow and the stresses resulting therefrom.

The difficulties associated with (1) and (2) are obviously closely related. It is, however, convenient to

* Abstract of paper read at the Spring Meeting of the Institution of Naval Architects, April 11, 1924.

consider under (1) those questions more particularly appertaining to the fuel sprayer.

The air injection method will only be referred to, in so far as it gives, in the present state of development, the most efficient combustion when developing mean pressures of the order of 130 lb. per sq. in. and above. It may be stated, however, that the success so far achieved with air injection of the fuel, when working with mean pressures of the above order, is undoubtedly due, in part, to the supercharging effect of the blast air.

A consideration of the conditions under which fuel injection has to be effected in high-speed engines developing high mean pressures leads to the conclusion that the usual fuel-spraying device, which consists, in the main, in forcing the fuel with injection air through a number of small holes in a series of washers (see Fig. 1, below) is unsuitable. This conclusion was fully confirmed by the early tests carried out on the Digit engine, and referred to in the 1920 paper. It would appear that the frictional resistance incidental to forcing fuel and air through the tortuous passage offered by the small holes in the pulverising washers, and through in addition, perhaps, some form of director nozzle, may be so great as to preclude the possibility of passing the requisite amount of fuel in the short-time period available. As a result, the fuel accumulates and fills the fuel valve casing, &c., which leads in effect to a "solid injection" system, but with a nozzle totally unsuited to such conditions. In consequence, the combustion is bad.

Fig. 1.

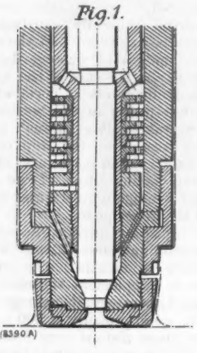
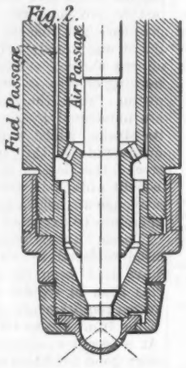


Fig. 2.



The essential feature, therefore, of the fuel sprayer to meet the conditions under review is a comparatively free passage for the fuel right down to the seating of the valve itself (see Fig. 2, above). It is beyond the valve seating that advantage must be taken of the velocity energy, obtaining in the fuel and air, for effecting whatever degree of pulverisation is possible or desirable. It will be evident that any attempt at controlling the distribution of the fuel, throughout the cylinder combustion space, can only be effected beyond the valve seating. It would appear, therefore, that an additional feature to be embodied in the fuel sprayer under consideration is a small chamber situated beyond the valve seating in which some degree of pulverisation can be obtained and upon leaving which a directional flow can be ensured. The design of this chamber, or nozzle, or its equivalent, has been found to be of great importance to the successful injection of fuel and consequent running of the engine.

A large number of the nozzles shown in Fig. 3, with varying sizes and angles of holes have been tried on the Digit and other engines. The type of nozzle indicated is suitable for a combustion chamber of hemispherical form and would require some modification for use with other forms of combustion chamber. The precise number, size, and angle of the holes in the nozzle necessary to ensure correct spraying of fuel are, of course, dependent upon a number of factors, including the amount of fuel to be injected, the time period of injection and the shape of combustion chamber. But experience shows that it is hardly possible to lay down any definite rule for calculating them, and any estimate for a new design is necessarily, even after taking some account of the new conditions, a rough shot; so the suitability requires to be demonstrated by actual tests in the engine.

Generally speaking, however, it may be stated that for the type of engine under consideration a nozzle having a large number of small holes will not produce the correct type of spray or jet. For, whereas such a nozzle may give excellent pulverisation, the jets lack penetrative energy, an essential feature in the injection of the fuel.

Further, it appears likely that the large number of jets issuing from the nozzle tend to coalesce and so diminish the efficiency of the spraying. It has also been found that with a combustion chamber of hemispherical form, a nozzle having one of its holes disposed on the centre line (Fig. 3,) invariably gives inferior results. This is doubtless due to the fact that the volume of air with which the central jet is associated in spraying, is a very small percentage of the total volume of the combustion chamber, and in consequence the central jet has insufficient air for its efficient combustion. In other words, the proportionate mixing of the air and fuel throughout the combustion chamber is not realised.

A further point of general interest in connection with the design of nozzles may be noted. It is the practice at the laboratory to "radius" the inner edge of the holes in order to reduce "eddying" and "fringing" of the jet; it is considered also that this tends to maintain the desired directional flow. This latter point is of importance as it is essential, if the best results are to be attained, that the fuel jets be directed at a particular angle with the vertical axis of the sprayer in order that the mass of air in the combustion chamber, on either side of the line of spraying, is approximately equal. That is to say, the jets must be directed towards the centre of mass of the volume of air with which they are

Fig. 3.

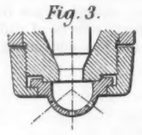


Fig. 4.

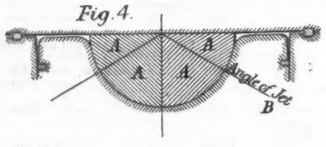
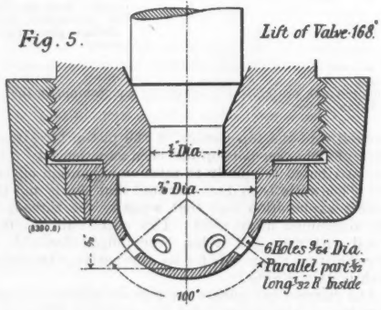


Fig. 5.



respectively associated. A reference to Fig. 4 above will make this point clear. In the figure the volumes of air represented by A are equal, the line B representing the direction of flow of the jet.

Reference may be made to the most recent type of nozzle fitted in the Digit engine, which has enabled mean pressures of the order of 130 to 140 lb. per sq. in. to be developed at 390 r.p.m. This nozzle is shown in Fig. 5 and its particulars follow:—

Number of holes....	6
Diameter of holes	9/64 in.
Included angle	100 deg.
Inside edges of holes radiused $\frac{1}{32}$ in.	

Attention may be directed to the comparatively thin walls of the nozzle chamber and the short length of the parallel portion of the holes. The latter reduces the frictional resistance to flow and enables a slightly smaller hole to be used; this in turn renders the nozzle more adaptable for dealing successfully with the lighter loads.

An indicator card, taken during a test with this nozzle fitted, is shown in Fig. 6. The mean pressure of the diagram is 142 lb. per sq. in. A record of the test shows that the engine ran steadily, developing 377 brake horse-power, excluding air compressor. The fuel consumption was 0·332 lb. per indicated horse-power and the exhaust was clear.

This is not regarded as being the upper limit to which the power development can be carried. Already, at lower speeds, mean pressures of 155 lb. per sq. in. have been successfully developed without supercharging, and the possibilities of carrying the high mean pressures at the higher speeds of revolution are being explored. It has been found that some modifications may be necessary in the main heat stressed members, comprising the combustion chamber, to permit this further development. This aspect will be dealt with later.

Determination of a Suitable Profile for the Fuel Cam Actuating the Sprayer.

The important part played by the sprayer nozzle in the function of "injection of fuel" has been noticed It is now proposed to examine the no less important question of obtaining a fuel cam profile which, in association with the particular mechanism adopted, will ensure the correct actuation of the sprayer fuel valve for dealing successfully with heavy fuel charges at the high speed of operation. It is not necessary in what follows to consider the actual shape of the fuel cam profiles, but rather the valve lift diagrams derived from them.

It will be appreciated that the rate and manner of the injection of the fuel has a vital bearing upon the resulting combustion, and that it is not sufficient merely to have the sprayer nozzle correct in all particulars; but it is also essential that the flow of fuel through the nozzle to the combustion chamber should be suitably regulated and timed in the manner to produce correct

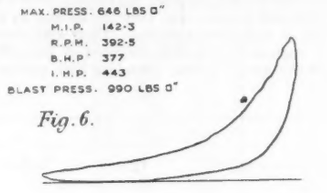


Fig. 6.

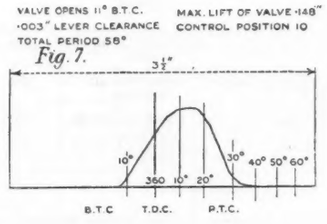


Fig. 7.

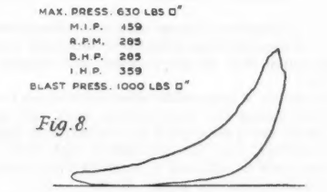


Fig. 8.

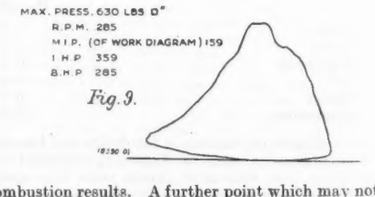


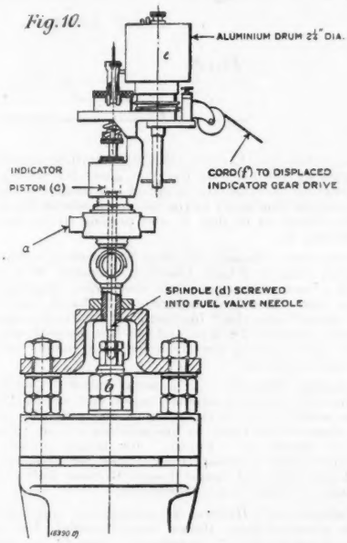
Fig. 9.

combustion results. A further point which may not be so readily appreciated, but which nevertheless has been established is that, whereas a certain fuel cam profile may give quite satisfactory results with heavy fuel charges at the lower speeds, it may be totally unsuitable for use at higher speeds; showing that the time element in the injection of the fuel, for which the fuel cam is responsible, is of vital importance, and its relation to the resulting combustion must be carefully considered. It was found in the case of the Digit engine in increasing the speed of engine to its designed limit, and employing the fuel cam and nozzle which allowed high mean pressures at low revolutions, that a very serious factor had to be faced, viz., detonation. The steps taken to eliminate this most undesirable feature, and the results of certain experiments with various fuel cam profiles fitted to the Digit engine will now be described. It may be stated that during the experimental work each fuel cam profile was tested in combination with several different nozzles, but it is proposed to note only the best results for each cam.

In the first place, it will be advisable to describe the valve lift diagram with which 150 lb. per square inch mean pressure at the lower speed of 285

revolutions, was obtained during a test. This diagram derived from the fuel cam in the manner to be described, is given in Fig. 7, whilst Fig. 8 shows the ordinary indicated work diagram taken with the same fuel cam in operation at the lower speed, and Fig. 9 gives the combustion diagram (taken by the usual "displaced drive" method) obtaining under the above conditions. The procedure followed to obtain the valve lift diagrams (Fig. 7, &c.) is shown in Fig. 10, and is as follows. An ordinary piston indicator *a* is mounted immediately over the top of the fuel needle valve *b*, which is actuated by the fuel cam under examination. The end of the indicator piston *c* is placed in contact with, and is actuated by, a projecting spindle *d* screwed into the end of the fuel needle valve. In order to obtain a conveniently long diagram for purposes of comparison a special pencil drum *e* is fitted over the ordinary drum, which is driven through the medium of the cord *f* from a crank, or eccentric, set at an angle of 90 deg. to the main engine crank. The diagrams are taken whilst the engine is being barred round and the 90 deg. displacement of the indicator driving crank has the effect of opening out the critical period in the lift of the valve, thereby facilitating the comparison of one lift diagram with another. It is convenient to take the actual fuel valve lift diagrams on tracing paper

Fig. 10.

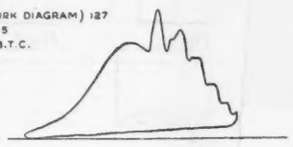


so that they may be superimposed and the result of any modification readily observed and compared. The lift diagrams obtained in the foregoing manner afford very valuable help in elucidating fuel injection problems. Some of the particulars of the test referred to are given on Figs. 7, 8 and 9. Additional extracts from the test sheet are :—

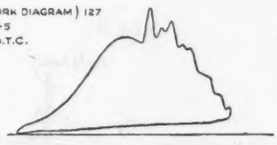
Fuel consumption per I.H.P. hour = 0·304 lb.
Fuel consumption per B.H.P. hour = 0·431 lb. (including for motor-driven compressors).
Colour of exhaust = shaded.
Fuel nozzle six ½-in. holes (countersunk internally) on 120 deg. included angle.
Brand of fuel : Texas S.G. 0·907.
Running of engine satisfactory and uniform.
No detonation.

It will be observed that, in the above comparatively "low speed-high mean pressure" tests, no detonation occurred and also that the total fuel valve lift period was only 58 deg. of crankshaft travel. On speeding up the engine to 390 r.p.m. detonation prevented a higher mean pressure than 120 lb. being employed when using the nozzle and fuel valve lift indicated in Figs. 2 and 7 respectively. Retaining the fuel cam of Fig. 7, various changes were made in the sizes of holes in the sprayer nozzle, but this did not provide any sensible improvement. It was then concluded that the time available during the 58 deg. period of valve lift, i.e., 0·025 sec., was too short for the normal combustion of the heavier fuel charges corresponding to the higher speed of revolution. In other words, that the injection of the fuel was too sudden and resulted in violent and erratic combustion. Typical combustion cards, taken about this time, in which the effect of detonation is clearly shown, are given in Figs. 11, 12 and 13, the corresponding mean pressure being about 127 lb.

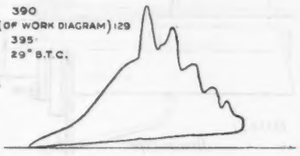
R.P.M. 390
M.I.P. (OF WORK DIAGRAM) 127
I.H.P. 390·5
TIMING 18° B.T.C.
Fig. 11.



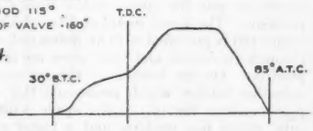
R.P.M. 390
M.I.P. (OF WORK DIAGRAM) 127
I.H.P. 390·5
TIMING 18° B.T.C.
Fig. 12.



R.P.M. 390
M.I.P. (OF WORK DIAGRAM) 129
I.H.P. 395
TIMING 29° B.T.C.
Fig. 13.



LEVER CLEARANCE ·003"
VALVE OPENS 30° B.T.C.
TOTAL PERIOD 115°
MAX. LIFT OF VALVE ·160"
Fig. 14.

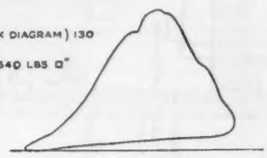


It was then decided to increase the valve lift period by fitting wider angle fuel cams. Several of the latter, giving longer periods, were tried in combination with various sprayer nozzles. The test results with these fuel cams showed some improvement so far as detonation was concerned, upon those obtaining with the 58 deg. period cam, but generally left much to be desired. Experimenting in the direction of "increased fuel period" was, however, continued, and particular reference may be made to a special type of fuel cam form which was amongst those tested and which gave promising results.

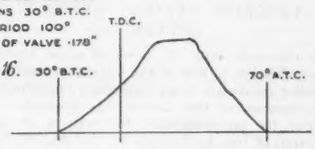
The valve lift diagram taken with this cam is shown in Fig. 14. It will be observed that the cam is of the double lift variety. The idea underlying this design is to inject the fuel in two stages, the first stage involving only the smaller portion of the fuel charge which, becoming ignited on injection, would create a high temperature zone for the reception and combustion of the following main fuel charge. A combustion diagram taken during a test with the "double lift" cam in operation is given in Fig. 15. There was no detonation during this test; but the increased noise attending the mechanical operation of this double cam was an unfavourable feature. Other particulars from this test are :—

Mean pressure	....	130 lb. per square inch.
Brake horse-power	....	333
Fuel consumption	....	0·493 lb. per brake horse-power. (including for compressor).
Exhaust	....	Clear.
Fuel nozzle	....	Six ½-in. holes on 120 deg. angle.

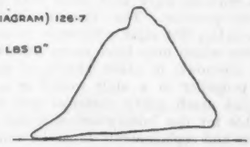
R.P.M. 390
M.I.P. (OF WORK DIAGRAM) 130
I.H.P. 398
MAX. PRESS. 640 LBS □"
Fig. 15.



LEVER CLEARANCE ·003"
VALVE OPENS 30° B.T.C.
TOTAL PERIOD 100°
MAX. LIFT OF VALVE ·178"
Fig. 16.



R.P.M. 395·6
M.I.P. (OF WORK DIAGRAM) 126·7
I.H.P. 397
MAX. PRESS. 605 LBS □"
Fig. 17.



The ultimate solution of the detonation problem with heavy fuel charges at high speeds was found in a long-period fuel cam giving a comparatively gradual opening and closing of valve. The valve lift diagram taken with this cam is given in Fig. 16. It will be noticed that the total fuel period is 100 deg. of crank travel, representing at 390 r.p.m. a period of 0·042 sec. Fig. 17 shows a typical combustion card and Fig. 6 an ordinary indicator diagram taken with this cam in operation. The sprayer nozzle ultimately used, in combination with the above fuel cam, and which gave the best results with the heavy fuel charges has already been referred to and is shown in Fig. 5.

The general particulars of a test with the latter combination of fuel cam and sprayer nozzle are :—

R.P.M.	....	392·5.
Mean pressure	....	142 lb. per square inch.
B.H.P.	....	377.
I.H.P.	....	443.
Fuel per I.H.P. hour	....	0·332 lb.
Exhaust	....	Clear.

No difficulty was found in obtaining this power and the engine ran steadily.

The foregoing brief notice of some of the experiments with fuel cams and sprayer nozzles will serve to indicate how vital is their influence on the output and behaviour of the engine generally.

Typical results from a series of trials carried out on the engine with the long-period cam are shown in Table III.

(To be continued.)

TABLE III.—DIGIT ENGINE.

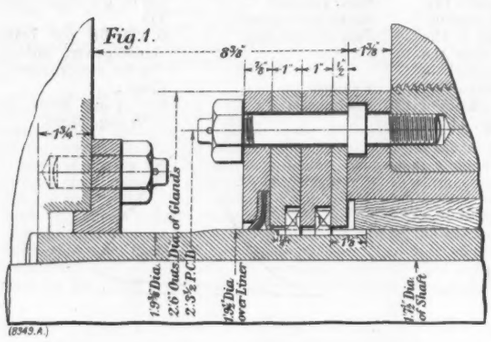
Mean Results of Trials with 100 deg. Fuel Cam Toe-piece and Six ⅛-in. Holes in Sprayer Cap (see Figs. 5 and 16).

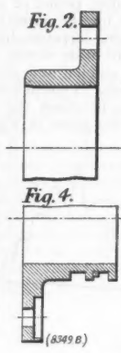
R.P.M.	I.H.P.	B.H.P.	Mean Indicated Pressure.	Mechanical Efficiency.	Maximum Pressure.	Compression Pressure.	Timing degrees B.T.C.	Blast Pressure.	Fuel. lb. per I.H.P.-hour.	Fuel. lb. per B.H.P.-hour.	Exhaust Temperature.	Remarks.
			lb. per sq. in.	Per cent.	lb. per sq. in	lb. per sq. in.	Actual.	lb. per sq. in.			deg. F.	
392	392·5	342	126·2	87·2	630	495	24	930	0·327	0·376	764	Texas oil used.
395	392	344·5	125·1	87·9	630	495	24	930	0·328	0·373	766	Exhaust was clear during all trials. No corrections have been made for power required by separately driven injection air compressor.
398	409	350	132·6	85·5	630	495	22	930	0·322	0·376	790	
394	410	355	131·0	86·5	630	495	22	920	0·328	0·379	823	
392	419	357	132·0	87·0	630	495	22	945	0·333	0·382	832	
392·5	443	377	142	85·9	630	495	22	990	0·332	0·386	878	
354	295	255	105	85·5	630	495	23	800	0·315	3·368	631	Trials at reduced powers. Approximate law : Power ∝ (speed)³.
312	211	166	85·2	78·6	630	490	25	750	0·310	0·395	458	
254	116	84·6	57·6	72·9	570	480	20	640	0·301	0·413	295	

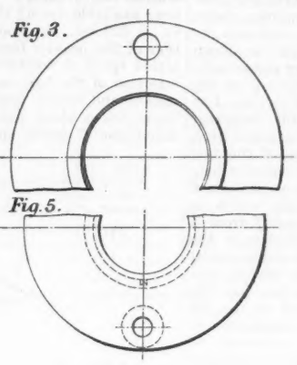
ENGINEERING AND LAW-MAKING.—According to *The Iron Age*, New York, Dr. N. M. Butler, President of Columbia University, at the annual dinner of the American Engineering Council, said that "what we want, what the people of the United States and the world want, is more emphasis on administration and less on legislation; more emphasis on the engineer and less on the law-making power. The United States," he added, "pass 14,000 or 15,000 laws every year and violate 12,000 every day, of necessity—and a great many people believe that political progress has been made. On the other hand, the real field for progress is the field of administration." Business men will agree with Dr. Butler when he says "we must leave-off artificial law-making and emphasise public administration, develop administrators, put them in their places, give them opportunity, hold them responsible and remove as fast as possible such artificial barriers as exist between the people and the expression and carrying out of their will."

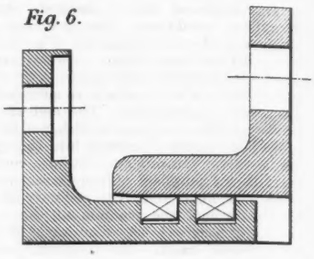
STERN-TUBE APPLIANCES AT THE BRITISH EMPIRE EXHIBITION.

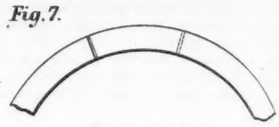
THE B. R. VICKERS (LEEDS) ENGINEERING COMPANY, LIMITED, ENGINEERS, LEEDS.

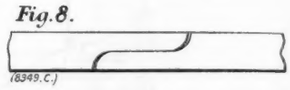












VICKERS' "VISTA" STERN-TUBE APPLIANCES.

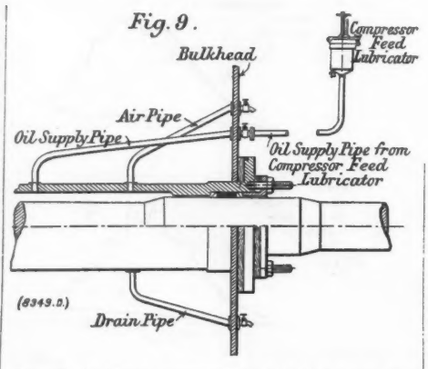
As the tail shaft of a vessel must transmit the whole effective power of the engine or turbine to the propeller its design is an important consideration, not only because of the factor of strength but also because its inaccessibility for repairs at sea. The reduction of loss by friction at this end of the transmission system warrants as much consideration as at any other point, but the problems involved are not always dealt with in ways that meet with general approval in other practice. That this should be so is, perhaps, remarkable, but rigid adherence to an old established practice which may have many disadvantages has not been unknown in other phases of engineering work. The propeller of a ship works in a medium which contains much gritty material and is, therefore, unsuitable for the lubrication of a tail shaft, of which repairs and replacements must be reduced to a minimum. Galvanic corrosion has also resulted in the impairment of the strength of tail shafts when the liner arrangements have been conducive to its production. When continuous liners have been used, extending from the stern stuffing box to the propeller hub, protection against corrosion has been obtained as long as tightness was maintained.

The introduction of oil into the stern tube has provided a complete solution of the corrosion difficulty and its presence ensures that the gritty waters of the sea, and the corrosive waters, containing decomposing vegetable and other organic matter brought down by inland rivers, are kept away from contact with the tail shaft. The B. R. Vickers (Leeds) Engineering Company, Limited, of Tooks Court, London, E.C. 4, have designed a number of stern-tube appliances for service in reducing the friction in the transmission of power to the propeller and the elimination of corrosion. On the stand of Messrs. W. M. Swinburne and Sons (1920), Limited, of Wallsend-on-Tyne, at the British Empire Exhibition, examples of these are shown, the details of some of which are depicted in the accompanying illustrations.

Fig. 1 shows a design in which a liner on the shaft extends into the propeller boss, and a ring of L-shaped cross section connected by studs to the boss increases the protection afforded. Oil-tightness for the end of the stern-tube is ensured by the use of three gunmetal glands in halves provided with lap joints. These are held together with studs passing through them and a guard ring mounted beside the stern-tube bush. In recesses cut on two of the glands metallic rings are introduced while washers of felt and of rubber composition are provided at the inside of the outside gland to ensure tightness to oil and against the sea water.

The following illustrations, Figs. 2 to 8, show the construction of the components of the telescope type of stern-tube appliances. The two rings, Figs. 2 and 3, and Figs. 4 and 5, are associated as indicated in Fig. 6. Holes are provided in each to make possible their connection to either the stern-tube or to the propeller boss. The spring rings are scarfed, as shown in Figs. 7 and 8, to give absolute tightness against the entry of sea-water under all conditions. A guard ring is usually fitted around the whole arrangement leaving very little space beside the propeller boss and preventing the entrance of foreign matter. In the case of twin- or triple-screw vessels these devices may be connected up to the A brackets and a modified design may be introduced at the inside of the brackets and at the end of the stern-tubes to obtain protection at both supports.

The arrangement adopted for the introduction of the oil and its retention in the system is clearly indicated in Fig. 9. The lubricator is of the spring-loaded type.



Through the hinged cover, which is held in place by a simple wing nut, there passes a screw which can be turned to put the spring below into a state of compression. The lower metal end to which the spring is connected is provided with an index rod, which extends through the cover and thus gives an indication of its position. On the bottom of the screwed rod there is a leather bucket which presses on the oil. A simple pipe conveys the oil to the space within the stern-tube which has packing and a gland at its forward end. An air pipe is provided so that it is possible to make certain that the tube is filled with oil while a drain pipe is also fitted to facilitate testing for the presence of water.

CATALOGUES.

Lubrication.—The Henry Wells Oil Company, 11, Haymarket, London, S.W.1, have sent a priced list of oils with some interesting notes on lubrication.

Oil Purifier.—An illustrated description of the Monarch centrifugal oil purifier is to hand from Mr. O. N. Beck, 11, Queen Victoria-street, London, E.C.4.

Coal Cutters.—A copy of the French edition of their explanatory pamphlet on coal-cutting machines is to hand from Messrs. Cowlishaw, Walker and Co., Limited, Stoke-on-Trent.

Photo-Copying Machines.—Messrs. J. Halden and Co., Limited, 8, Albert-square, Manchester, have forwarded a catalogue of their continuous electric photo-copying machines giving particulars of the types and sizes made, current consumption, speed of operation, &c.

Heating Apparatus.—Cast-iron boilers of single and sectional types for heating water and supplying radiators for domestic and other use are dealt with in a number of catalogues to hand from the Beeston Boiler Company Limited, Beeston, Notts. Prices and full particulars are given.

Chemical Plant.—A catalogue illustrating some of the many machines and utensils which enter into the equipment of chemical works, including stills, rectifiers, condensers, mixers, autoclaves, driers, pans, tanks, conveyors, &c., is to hand from Messrs. W. J. Fraser and Co., Limited, Dagenham, Essex.

Steel.—A catalogue of steel bars made of a special class of mild steel which is particularly easy to machine is to hand from The Steel Nut and Joseph Hampton, Limited, Wednesbury. The list of bright bars of stock sizes in hexagons, rounds and squares includes all usual dimensions finished to within 0·002-inch, while sizes of flat sections will be furnished on request.

Air Heater for Boilers.—A catalogue received from the Underfeed Stoker Company, Limited, Aldwych House, Aldwych, London, W.C.2, describes apparatus for utilising the heat in the flue gases for raising the temperature of the air supplied to boiler furnaces. An example illustrated in the catalogue shows air entering the heater at 60 deg. F. and passing to the furnace at 220 deg. F.

Motor Cars.—Messrs. Gwynnes Engineering Company, Limited, Church Wharf, Chiswick, London, W.4, have issued a new edition of their descriptive catalogue of motor cars. The firm construct two chassis known as the "eight" and the "fourteen," of which the engines actually develop 20 h.p. and 30 h.p. respectively, at 3,000 r.p.m. Prices are given for both chassis and for fully equipped cars.

Foundry Materials.—A material called "Cupoline," for lining or repairing cupolas, ladles, converters, furnace doors, soaking pits, boiler settings and generally taking the place of fire brick or fire-resisting cement; and a powder known as "Finitol" for facing moulds, are described with practical instructions for their use, in catalogues received from Messrs. Robson Refractories, Limited, 1, North-road, Darlington.

Multiple Drill Heads.—A catalogue of multiple-drill heads received from Messrs. Jigs, Limited, 132, Long Acre, London, W.C.2, illustrates a variety of arrangements for driving from four to twelve drills simultaneously, and also for adjusting the spacing on a straight line or circle. Tables of limits of adjustment are given for four standard patterns, but the firm also design special drill heads to meet particular requirements.

Sluice Gates, &c.—Messrs. Ransomes and Rapier, Limited, Ipswich, send us a copy of their "R. and R. Annual," containing 48 pages of articles; and also particulars of various mutual benefit and amusement organisations of the staff. The articles deal with the Sennar, or Blue Nile, dam; a coaling transporter at Hull, water control and several other subjects. The annual is well produced and contains much material that is worth recording.

Feed-water Regulator.—An explanation of Cope's system of boiler feed-water regulation with ample illustrations, is given in a catalogue received from Messrs. James Gordon and Co., Limited, Windsor House, Kingsway, London, W.C.2. The object of the apparatus is to regulate the supply of feed water automatically in accordance with the output of steam. The parts of the apparatus are described and their application to a Lancashire boiler is illustrated.

Driving Chains.—The Coventry Chain Company, Limited, Coventry, have sent us a copy of their catalogue containing, as usual, a great deal of useful practical matter relating to the application of chain transmission, methods of erection, lubrication, maintenance, &c. Separate sections are devoted to inverted tooth chains, roller chains and chains for special purposes, a chain coupling for shafts and a shock-absorbing wheel. Many illustrations are given indicating that the use of chain drive is extending in collieries, textile mills, flour mills, engineering works and other industrial concerns, as well as on motor vehicles.

MESSRS. BILTON'S EXHIBITS AT SOUTH KENSINGTON MUSEUM.—At the request of the Board of Education, Messrs. T. B. Bilton and Sons, Limited, North Shields, have sent to the Science Museum at South Kensington for exhibition models of their expansion joint and hydraulic pipe bending machine. They are to form part of a collection which is now being arranged to represent recent practice in engineering manufactures.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

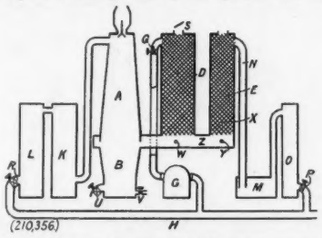
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

GAS ENGINES, PRODUCERS, HOLDERS, &c.

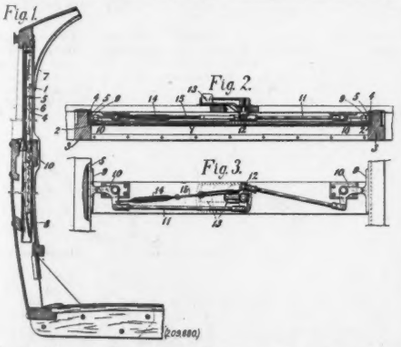
210,356. M. W. Travers, London, and F. W. Clark, Lymm. Manufacture of Gas. (1 *Fig.*) June 29, 1923.—The invention relates to the manufacture of gas and, according thereto, the gas is enriched by passing a portion thereof, which has been regeneratively heated, through a chamber which has been heated by the "blow" gases and into which a hydrocarbon oil is introduced. A is the carbonisation chamber and B the gasification chamber. A passage through which the blow gases pass, connects the gasification chamber B to the bottom of a regenerator D provided with a stack valve S and a secondary air inlet W. U and V are valves for admitting air and steam respectively beneath the chamber B. During the run, gas passes from the top of chamber A through a scrubber K and condenser L, past a valve R to the main H which leads to the gas holder. From a convenient point in the main H a by-pass leads to a circulator G adapted to force some of the gas from the main past a valve Q to the top of the regenerator D. E is the enriching chamber which is filled with brick chequer work and communicates by a passage Z with the regenerator D. In the bottom of the chamber E is a secondary air inlet Y. X is a sprayer by which oil can be introduced into the chamber E, from the top of which a pipe N leads to a wash box M from which the enriched gas issues to a cooler O, and so through a valve P to a point in the main between the intake of the circulator G and the gas holder. In operating the plant, the valves P, Q and R are first closed, the stack valve S and a stack valve on the enriching chamber E and the air-blast valve U are opened and air is blown into B till the temperature is raised sufficiently for the production of water gas by subsequent steaming. During this operation the blow gas,



containing carbon dioxide and carbon monoxide, passes through the channel Z and is distributed through the vessels D and E in proportions which can be regulated by restricting the openings of the stack valves. Secondary air may be admitted at W and Y. Thus the temperatures to which the vessels D and E are raised during the blow period can be controlled and regulated. At the end of the blow period the secondary air is cut off at W and Y and the air blast valve U is closed. The steam valve V is opened, the stack valves are closed, and the valves P and R are opened. The circulator G is set in motion, the valve Q is opened, and oil is sprayed into E by the sprayer X. The water gas generated in B passes upwards through the coal in A, and with the gas produced by the distillation of the coal passes through the scrubber K and the condenser L to the main H. Some of this gas is forced by the circulator G to the top of the regenerator D, and passes through it, being heated in the process. The stream of gas divides at the bottom of the regenerator. Part of it enters the bottom of the carbonisation chamber A through the channel connecting it with D and part of it passes through the channel Z into the bottom of the carburettor E and flows upwards together with the sprayed oil, which, in contact with the hot brick work, and by the action of the hydrogen in the gas, is converted into permanent hydrocarbon gas. The enriched gas passes through the pipe N, the wash box M, the cooler O and the valve P to the main H, and as the quantity of gas passing the valve P can be controlled, the quantity of gas entering the carburettor E is also under control. (*Accepted February* 6, 1924.)

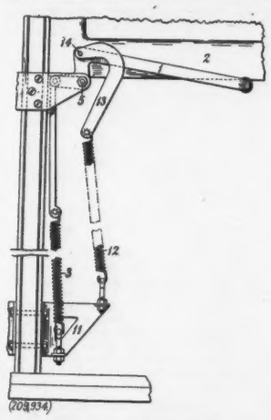
MOTOR ROAD VEHICLES.

209,880. The British Electrical Federation, Limited, Holborn, London, A. Twidle, Kensington, London, and



E. P. Worsfold, Holborn, London. Controlling Drop Windows. (4 *Figs.*) November 10, 1922.—The invention relates to means for controlling drop windows. The window 1 moves in guides 2, 2 secured to the side framings 3, 3. On each side frame is secured a fixed member 4 which extends from towards the top of the window framing into the slot into which the window moves in its lowered position. By the side of the fixed member 4 is arranged a locking member 5 of substantially the same length as the fixed member 4. The fixed member 4 and the locking member 5 have their co-operating surfaces in the form of a series of inclined planes 6 so that when the wedge-shaped locking member 5 moves downwards it is also moved outwards in relation to the fixed member 4 and against the window 1 to press the latter against the window frame. Each wedge-shaped locking member 5 is held in contact with the fixed member 4 by small spiral springs 7, 8, one at each end. On each wedge-shaped locking member 5, at about the middle, is mounted a bracket 9, to which is connected one end of a bell-crank lever 10. The opposite ends of the levers 10 are connected by links 11 to opposite ends of a centrally pivoted member 12, which member is formed integral with an operating handle member 13. The links 11 may be adjustable in length. The member 12 is also connected to one of the bell-crank levers 10 through a spring 14, whose tension may be adjusted by varying the effective length of the link 15. The spring 14 acts to pull the wedge-shaped locking members 5 downwards and thus outwards to cause them to press the window 1 against the window frame 3 and hold it in any position desired. If the position of the window is to be altered the operating handle 13 is turned, whereby the bell-crank levers 10 are moved to raise the wedge-shaped locking members 5 and thus release the pressure on the window. On releasing the handle 13, the wedge-shaped locking members 5 are returned to their operative position by the action of the spring 14. The window 1 may be provided with springs to counter-balance its weight. (*Sealed.*)

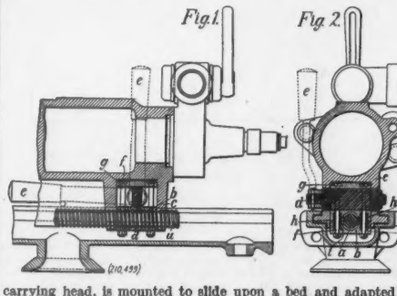
209,934. The British Electrical Federation, Limited, Holborn, London, A. Twidle, Kensington, London, and E. P. Worsfold, Holborn, London. Balance Gear of Drop Windows. (2 *Figs.*) January 6, 1923.—The invention has relation to the means by which the weight of a drop window is counterbalanced and the window automatically held in the position to which it has been moved. Balance gear of drop windows, in accordance with the invention, comprises a lever 1 bearing at one end against the under side of the bottom rail of the window 2, a spring 3 connected to the other end of the lever acting in opposition to the weight of the window and a second spring 12 also connected to the lever 1 to vary the action of the spring 3 on the lever 1, so that the window is held stationary in the position to which it is moved. The compensating spring 12 is anchored at one end to the bracket 11 and at the other end is connected to one end of a link 13. The link 13 is of curved shape and is constituted of two plates, which are disposed on opposite sides of the lever 1 and are secured together at their ends. The position



of the pivotal points 5, 14 and the loading of the springs 3, 12 are such that the weight of the drop window 2 is counterbalanced and the window automatically held in any position into which it may be moved. When the drop window is raised to a position in which the pivotal points 14, 5 and the point at which the compensating spring 12 is anchored to the bracket 11 are in line, the pull of the spring 12 is in such direction that it does not assist or oppose the pull of the spring 3. When the drop window is raised above the position just mentioned, the pivotal connection 14, with the spring 12, moves to a position in which a line joining the pivotal point 14 and the anchor point of the spring 12 passes to the left of the pivotal point 5; the spring 12 is then operative and tends to assist the spring 3. When the drop window is lowered from the position first mentioned, the pivotal connection 14 is moved to a position in which a line joining it with the anchor point of the spring 12 passes to the right of the pivotal point 5; the spring 12 is then operative and tends to oppose the spring 3. (*Sealed.*)

MINING, METALLURGY AND METAL WORKING.

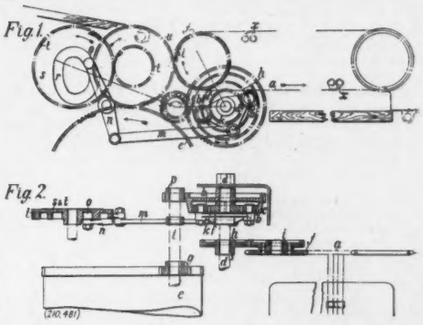
210,499. W. H. Dorman and Co., Limited, Stafford, and R. G. Hanson, Stafford. Rock Drills. (2 *Figs.*) October 27, 1922.—The invention relates to rock drills in which the drill-



carrying head, is mounted to slide upon a bed and adapted to be fed towards the work by means of a lead screw and split nut, and is provided with means whereby the head can be temporarily disconnected from the lead screw by the separation of the halves of the split nut to permit the head to be moved quickly by hand. According to the embodiment of the invention illustrated, the feed mechanism comprises a lead screw *a*, which is rotated by a motor, and a split nut *b* carried by the movable head *c*, the two portions of which nut tend to become separated and out of engagement with the lead screw by means of springs so that the head is free to be moved quickly by hand. The two portions of the split nut are adapted to be forced together by means of a cam *d* having two dimensions. This cam is mounted to rotate upon one side of the movable head and provided with a handle *e* to enable it to be operated. The two halves of the split nut are mounted to slide upon a pair of guide pins *f*, the upper ends of which carry a saddle piece *g* which rests upon the uppermost surface of the cam. The sides of the cam thus bear against the underside of the saddle piece and the top surface of the upper half of the split nut. Thus when the cam is turned so that its smaller dimension opposes the saddle piece and the nut respectively, the two halves of the nut are free to be forced apart by the aforementioned spring arrangement so as to disconnect the head of the drill from the lead screw. Upon imparting a quarter turn to the cam, the two halves of the nut are forced together, thus locking the drill head to the lead screw. The spring arrangement aforementioned may conveniently consist of a pair of helical springs *h* disposed in pockets *i* in the two halves of the nut and surrounding the two guide pins *f*. (*Accepted February* 13, 1924.)

PRINTING AND ALLIED MACHINERY.

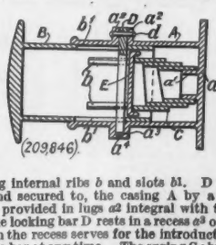
210,481. T. F. Elsworth, Hunslet, Leeds, F. W. Wright, Hunslet, Leeds, P. Harker, Hunslet, Leeds, and George Mann & Co., Limited, Hunslet, Leeds. Printing Machine Delivery Mechanisms. (2 *Figs.*) October 3, 1922.—The invention relates to delivery mechanisms for printing machines and consists in a printing machine having an impression cylinder continuously rotating at a uniform speed, in which the delivery chains receive a sheet direct from the impression or take-off cylinder and are driven throughout the working cycle by a single gear train which is so constituted as to increase the speed of the delivery chains above the uniform peripheral speed of the impression or take-off cylinder at an appropriate moment in order to gain length of travel. In carrying the invention into effect, a differential gear mechanism is arranged in the train of gears through which the chains *a* are normally driven. The differentia pinions *b*, *b* gear on the one hand with the driving member *c*, which takes the form of an internal toothed wheel loosely mounted on the shaft *d* and driven by the printing cylinder *e* through gears *g* and *p* secured to spindle *l*, and on the other hand with the driven member *f*, which takes the form of an ordinary spur gear, keyed to the spindle *d*, which also carries in rigid relation the spur wheel *h*, serving by way of the intermeshing wheel *i* to transmit the desired motion to the chain wheel *j*. A rocker *k* carrying the differential pinions *b*,



b is freely mounted upon the common spindle *d* of the driving and driven members and connected by a link *m* with a double lever *n* carrying a runner *o* at one end engaging with the groove *r* of a cam *s* which is rotated at a uniform speed and in definite timed relation with the machine by gearing *t*, *t* from the spindle of the impression cylinder *u*. The cam groove is so formed that the following action takes place:—With the runner *o* in engagement with a certain concentric part of the groove, the rocker *k* carrying the differential pinions *b*, *b* has no rotation about its axis and the chains are then driven at normal speed, *i.e.*, the peripheral speed of the impression cylinder *u*, the differential member being locked by the cam. The chain grippers *x* seize the sheet at a convenient point after the runner has engaged the concentric part of the cam groove referred to, which is of suitable length to maintain the differential member locked until the sheet to be delivered is clear, or nearly so, of the impression cylinder *u*. The runner now engages with an eccentric part of the cam groove which causes the rocker to move about its axis in a direction to increase the speed of the chains. Subsequently, the runner engages with a further portion of the cam groove which is likewise eccentric, so that the rocker is moved in the reverse direction, thereby reducing the speed of the chains below the normal, and even stopping them momentarily in which case their motion may be described as intermittent. (*Accepted February* 13, 1924.)

RAILWAYS AND TRAMWAYS.

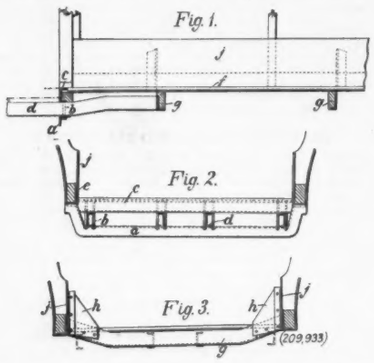
209,846. J. Mitchell, Putney, London, and J. C. G. Cossey, Golders Green, London. Buffers. (11 *Figs.*) October 20, 1922.—The invention relates to self-contained buffers. A is the casing, of which the end plate *a* is integral with the body of the casing. A tubular internal projection a^1 ensures the central position of the volute sping C. B is the



plunger having internal ribs *b* and slots b^1. D is a locking bar inserted in, and secured to, the casing A by a rivet *d* passing through holes provided in lugs a^2 integral with the casing. The lower end of the locking bar D rests in a recess a^3 of the casing and a small hole a^4 in the recess serves for the introduction of means for pushing out the bar at any time. The spring C abuts at its rear end against the base *a* of the casting and at its front end against a

plate or washer E which in its turn abuts against the ribs *b*. The outward stroke of the plunger is limited by the length of the slots *b*1. (*Sealed.*)

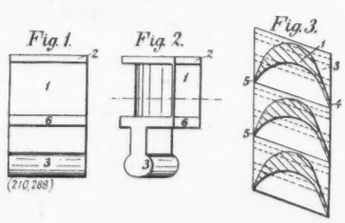
209,933. The Brush Electrical Engineering Company, Limited, Loughborough, and W. E. Hall, Sutton. Underframes for Tramway Vehicles. (5 *Figs.*) January 3, 1923.—In tramcars it is usual to employ an under-frame in which the upper surfaces of the sole bars and headstock occupy the same, or substantially the same, horizontal plane, the floor being supported in, or adjacent to, said plane by cross-bars, whilst the platform bearers extend beneath the headstock. The object of the invention is to effect certain improvements. To this end it is arranged that the platform bearers *d* shall be borne upon a transverse member *a* having upward-directed ends for attachment to the sole bars *e* and adapted to be connected to a relatively light head-



stock *c*, the upper surface of which is well below the level of the upper surfaces of the sole bars. The connection between the transverse member *a* and headstock *c* may be effected with the aid of bolts *b* located at, say, opposite sides of the platform bearers or, if greater strength is desired, gusset plates or their equivalent may be employed to brace the parts together, in addition to bolts *b*. The cross members *g* which support the floor *f* have ends inclined upwards and adapted to be connected to the sole bars by gussets *h*, which in turn are fixed to the usual steel truss plating *j* of the vehicle. The formation of the cross members is such that the floor is lowered to the level of the top of the headstock, the whole constituting a well type of under-frame. (*Sealed.*)

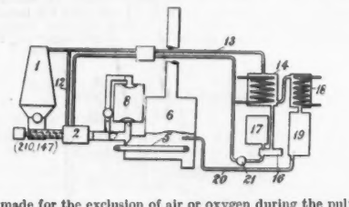
STEAM ENGINES, BOILERS, EVAPORATORS, &c.

210,288. The English Electric Company, Limited, London, and J. P. Chittenden, Rugby. Turbine Rotors. (3 *Figs.*) February 1, 1923.—The invention relates to the wheels of elastic fluid turbines of the kind in which the attachment of the blades is effected by the engagement of the roots of the blades with undercut grooves placed transversely in the rim of the wheel. In accordance with the invention, blade mountings of the type indicated are made stronger than with known dispositions by making the transverse grooves in the rim at an appreciable inclination to planes containing the axis of the



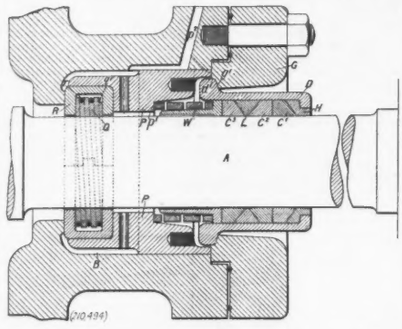
wheel and disposing and forming the roots of the blades in a manner appropriate for insertion in these inclined grooves. The blades 1 have flanges 2 and 6 at their outer and inner ends respectively, and bulbous roots 3 at their inner ends. When assembled, the edges 5 of the blades are in advance circumferentially of the edges 4. The roots 3 fit in correspondingly shaped grooves cut in the rim of the wheel, and the inclination of the grooves is so chosen that the sides of the root 3 are parallel with lines 5-4 joining the two edges of the blades. (*Sealed.*)

210,147. Electrical Improvements, Limited, Westminster, London, and C. H. Merz, Westminster, London. Fuels. (1 *Fig.*) October 24, 1922.—The invention has for its object to prepare a new form of fuel which will be suitable for use in boiler and other furnaces. The invention is applied solely to the treatment of coke material and not to the treatment of raw fuel. According to the invention, a new fuel is prepared by pulverising coke in an inert fluid medium at a temperature of approximately 450-650 deg. C., the provision



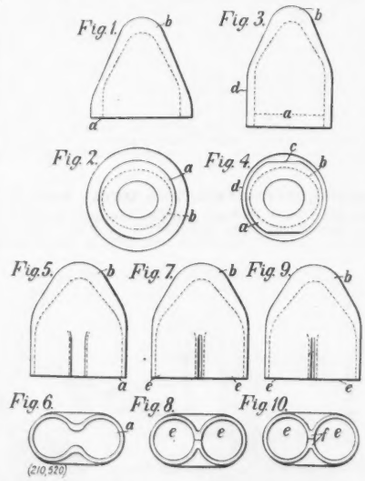
being made for the exclusion of air or oxygen during the pulverisation. In a preferred manner of carrying the invention into effect, coke obtained from a low temperature distillation retort 1 is fed direct into an enclosed pulverising apparatus 2. The finely divided fuel obtained from the pulveriser is then fed in a heated condition directly on to grate 5 of the furnace 6; or the fuel may be stored in a tank 8, and subsequently supplied to the furnace. In the plant illustrated, a proportion of the gases from the retort 1 pass by a pipe 12 to the crusher 2 or by a pipe 13 to a condenser 14. Distillates from the condenser 14 pass into a receiver 16 with which communicates an auxiliary oil-tank 17. Uncondensed gases pass from the condenser 14 through a cooler 18 and thence to a gas stripping plant 19 from which some or all of the fixed gas is passed *via* a pipe 20 back into the furnace 6. From the receiver 16 a pump 21 serves to pump oil into the crusher 2. If it is desired to produce fuel having a colloidal nature oil is supplied to the crusher 2 by means of the pump 21 so that the fuel is immersed in oil during pulverisation. As will be understood from the diagram, the oil employed may be wholly or in part obtained from the carbonisation process, that is, the oil condensed in the condenser 14. An advantage of using oil obtained from the carbonisation process is that the oil is available in close proximity to the pulverising apparatus, thus avoiding unnecessary transit of the oil. (*Sealed.*)

210,494. The United Kingdom Self-Adjusting Anti-Friction Metallic Packing Syndicate, Limited, Liverpool, and F. G. Brooks, Seaforth. Metallic Packings. (5 *Figs.*) October 26, 1922.—The invention relates to metallic packings for stuffing boxes of the type in which the packing is divided into two sections, viz., a front section and a rear section. According to the invention, the packing rings of the rear section are made in segments and are maintained in position by cutting in the periphery of each ring one or more helical grooves, and threading into the groove or grooves one or more helical springs wound to a helix of slightly less diameter than the corresponding helix formed by the grooves, so that the springs when in position exert a radial compressing action on the packing ring and maintain it in jointing contact with the rod to be packed. A is the rod to be packed, and B a stuffing box formed on the end of the cylinder; the front packing comprises the anti-friction packing rings C1, C2 and C3 carried in the sleeve D, which also carries the end ring H and the double-cone ring L.



The sleeve D has a flange *d*1 which makes joint with a recessed facing *g*1 in the gland G. The joint between *d*1 and *g*1 is made by a spring W interposed between a facing *g*1 formed on the outer cover-ring P and the shoulder of a spring ring. The spring W, in addition to maintaining the joint between *d*1 and *g*1, also provides the necessary elastic axial pressure between the packing rings in the sleeve D. The packing ring Q of the rear section of the packing is carried in a "U" shaped cover-ring R, which is housed in a cylindrical recess in the rear end of the outer cover-ring P, the cover-rings R and P being held in position axially by the engagement of the nose *p*2 of the ring P in the gland G. The ring Q is composed of three segmental sections. In the periphery of the ring, either before it is cut into segments or afterwards, a helical groove *q*1 is cut, into which groove a helical spring T is threaded; the spring being wound to a helix slightly less in diameter than the helical groove, so that when the spring is inserted it exerts a radial pressure which closes the segments of the ring Q on to the rod A. (*Accepted February* 13, 1924.)

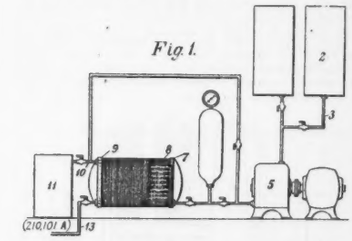
210,520. A. E. Hills, Aston, Birmingham, H. Trevorrow, Aston, Birmingham, and The Perfecta Seamless Steel Tube and Conduit Company, Limited, Aston, Birmingham. Superheaters. (16 *Figs.*) August 1, 1923.—The object of the invention is to provide an improved connecting piece especially adapted for the connecting of the

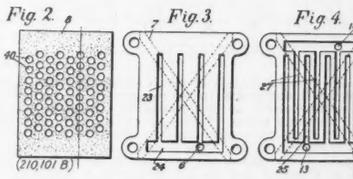


ends of superheater tubes. According to the invention, a connecting piece is formed from a cup-like body shaped at its open end to form a pair of sockets for the reception of the tube ends, and formed with a pair of internal and opposite flats providing parts of increased thickness as hereinafter described. In the production of a connecting piece, a steel disc or a solid billet is first shaped by pressing or drop forging operations to a cup form, as shown in Figs. 1 and 2. The open end *a* is of circular form, whilst the closed end *b* is of slightly elliptical form. This body is then subjected to similar or drawing operations, and its shape is modified, as shown in Figs. 3 and 4, the open end being thereby thinned and a pair of internal and opposite flats *c* formed at such end, the internal flats extending along the cylindrical portions *d* and forming a pair of parts of relatively greater thickness. In the next stage the body is extended laterally and the opposite sides having the internal flat portions are pressed inwards, as shown in Figs. 5 and 6. Afterwards the body is subjected to another operation which causes the open end to assume the form of a pair of circular sockets *e*, as shown in Figs. 7 and 8. Finally, the abutting portions *f* are welded together, as represented in Figs. 9 and 10. The ends of the superheater or other tubes are inserted into the sockets *e* and are welded in position. The essential novelty in this invention resides in the formation of the flats *c* in the initial stages of the shaping operations. In other particulars the production of the connecting piece is on similar lines to other previous proposals. (*Accepted February* 13, 1924.)

MISCELLANEOUS.

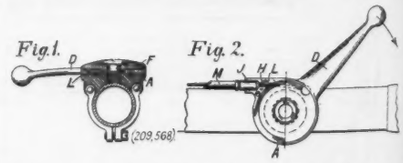
210,101. H. S. Hele-Shaw, Westminster, London. Filters. (20 *Figs.*) July 19, 1922.—The invention comprises a filter consisting of a pack of plates or sheets of material held sufficiently close together to prevent passage between them of the matter to be separated, provided with means for introducing the liquid to be filtered to the interior of the pack through one or more inlet tubes formed by coincident apertures in the faces of the plates and means for permitting the filtrate after passage between the sheets or plates to escape from the interior of the pack through one or more outlet tubes formed by coincident apertures in the faces of the plates. In the filter-press shown, the fluid to be filtered is stored in a tank 2 having an outlet 3 leading to the inlet of a motor-driven pump 5. The outlet of the pump 5 delivers fluid to an inlet end-plate 7 of a filter-press containing a series of plates 8 (Fig. 2) having a number of perforations 40 and held in the usual manner between the inlet plate 7 and an outlet plate 9. The outlet plate 9 is provided with a fluid discharge outlet 10 leading to a filtered fluid receptacle 11. The end plates of the filter are constructed as shown in Figs. 3 and 4, and the filter plates 8 are perforated with vertical rows of perforations all registering with one another. These perforations are divided by means of the specially constructed end-plates into two series of groups or vertical rows. Every alternate





vertical row of the perforations 40 opens into channels 23 in the inlet plate; these channels open into a common channel 24 into which opens the inlet 6 from the pump 5. The series of groups or rows of filter-plate perforations opening into channels 23 form passages which at their opposite ends open into channels 25 in the outlet plate of the press, and these channels open into a common channel 26 into which opens the drain pipe 13. This drain pipe, however, during the normal working of the press is closed, so that fluid pumped into the channels formed by the perforations can only escape between the plates to the other or alternate series of groups of perforations, and in doing so deposits the suspended matter in the passages formed by the registering perforations 40, and which is removed by a cleansing operation. The filtered fluid passing between the plates 8 to the alternate series of groups of perforations 40 passes through passages formed by these perforations 40 into a second series of channels 27 which open into a common channel 28, in turn opening into the outlet pipe 10 delivering filtered fluid into the reservoir 11. The filter plates may be made of paper or any other suitable material of a fibrous character having a grain or matt surface, or having projections or raised borders formed thereon by printing, or by depositing and securing thereon any suitable substance, and such material impregnated or otherwise made impervious to the action of the fluid or substance under treatment. (*Sealed.*)

209,568. A.M.A.C., Limited, Witton, Birmingham, and T. A. Tisdell, Witton, Birmingham. Bowden Wire Control Levers. (4 *Figs.*) November 29, 1922.—The invention relates to Bowden wire control levers of the type in which there is pivoted to a base a single lever having a reel or disc around which the cable passes, the casing entering and abutting against



a socket on the base. According to the invention, both the base A and the cover plate F are formed with a tangential channel H terminating in a groove J, which together form the circular socket for the casing M and the passage for the cable L. The lever D, with the cable attached, can be fitted in place on the base, the casing and cable thus dropping into place, after which the cover plate is fitted. (*Sealed.*)

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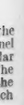

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